The Engineer.

Established 1856. Registered as a Newspaper.

OFFICE FOR ADVERTISEMENTS & PUBLICATION, 28, ESSEX ST., STRAND, LONDON, W.C. 2.

VOL. CLI.—No. 3934] LONDON: FRIDAY EVENING, JUNE 5, 1931 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

Tenders are Invited by the Director of Army Contracts for return on 22nd June, 1931, for the PURCHASE of SURPLUS MACHINERY and LIGHT RAILWAY PLANT (18in. gauge), lying at the Royal Arsenal, Woolwich, including :—

Drilling Machines, Capstan Lathes, Grinding Machines, Foundry Trucks, Screw-cutting Lathes, Hydraulic Press, Electric and Hydraulic Cranes, Wagons and Trucks (18in. gauge), &c. &c.

Tender forms with further particulars may be obtained on application to the DIRECTOR OF ARMY CONTRACTS, War Office (D.C.4), Caxton House West, Tothill-street, London, S.W. 1.

HEATING.

The Commissioners of His Majesty's Works, &c., are prepared to receive TENDERS before 11 a.m. on Wednesday, 17th June, 1931, for ACCELERATED LOW-PRESSURE HOT WATER HEATING at the British Museum Repository, Hendon, N.W.

Drawings, specification, and a copy of the conditions and form of Contract may be seen on application.

Bills of quantities and forms for Tender may be obtained from the CONTRACTS BRANCH, H.M. Office of Works, King Charles-street, London, S.W. 1, on payment of One Guinea. (Cheques payable to the Commissioners, H.M. Office of Works.) The sums so paid will be returned to those persons who send in Tenders in conformity with the conditions. 7045

Air Ministry. AN ASSISTANT CIVIL ENGINEER is REQUIRED in the Works and Buildings Directorate, age limits 25 to 28 years, on the 30th June, 1931, but service in H.M. Forces up to 5 years may be deducted from the candidates' actual age for this purpose. Candidates must be corporate members of either the Institution of Civil Engineers, Royal Institute of British Architects, Institution of Municipal and County Engineers, or holders of a Degree in Engineering, and have had at least two years' experience on important works. Commencing salary £250, rising by annual increments of £15 to £450, plus bonus (the aggregate salary range under present rate of bonus is £537 to £575 per annum).

The selected candidate will be appointed to a non-pensionable post, but an opportunity to compete for a pensionable post will probably arise.

Application forms are obtainable from the SECRETARY (W.B.5), Air Ministry, Kingsway, W.C. 2, and must be returned completed by the 23rd June, 1931. 7059

Civil Service Commission. FORTHCOMING EXAMINATION.—PROBATIONARY ASSISTANT ENGINEERS (MALE) in the Engineering Department of the Post Office (20-25, with extension in certain cases).

Regulations and particulars, together with the forms on which applications must be made, will be sent in response to requests (preferably by postcard), addressed to the SECRETARY, Civil Service Commission, Burlington-gardens, London, W. 1, GIVING THE TITLE OF THE SITUATION. The latest date for the receipt of application forms is 9th July. 6872

Indian Railway Service OF ENGINEERS.

The Secretary of State for India in Council will, in the near future, APPOINT ONE ASSISTANT EXECUTIVE ENGINEER to the Indian Railway Service of Engineers. Candidates must have attained the age of 21 years and must not have attained the age of 25 years on 1st January, 1931.

The appointment is for a Civil Engineer. Candidates must either (1) have obtained one of certain recognised University Degrees or other Distinctions in Engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination, or (3) have passed the Associateship in Engineering of the City and Guilds Institute (Imperial College of Science and Technology, South Kensington), or (4) produce evidence that they are otherwise eligible under the Regulations. They should, in addition, have had about one year's approved practical experience in engineering.

Applications from candidates must reach the India Office not later than 30th June, 1931. Printed forms, together with information regarding the conditions of appointment, may be obtained from the SECRETARY, Services and General Department, India Office, Whitehall, S.W. 1.

India Office,
28th May, 1931. 7048

Safety in Mines Research Board. The Safety in Mines Research Board REQUIRES the SERVICES of an experienced CIVIL or MECHANICAL ENGINEER in connection with the development of research into haulage problems in mines. Mining experience, while not essential, is desirable.

The post is a whole-time one, tenable at Sheffield, and carries a commencing salary of £750 per annum.

Forms of application, which must be returned not later than 20th June, 1931, can be obtained from the UNDER-SECRETARY FOR MINES, Establishment Branch, Mines Department, Dean Stanley-street, London, S.W. 1. 7047

Administrative County of LONDON.
ROBERT BLAIR FELLOWSHIPS IN APPLIED SCIENCE AND TECHNOLOGY.

The London County Council invites APPLICATIONS for the AWARD of TWO ROBERT BLAIR FELLOWSHIPS in APPLIED SCIENCE and TECHNOLOGY, each of the value of £450, tenable for one year. The Fellowships are for advanced study or research in applied science and technology and will be tenable in the Dominions, the United States, or other foreign countries.

Candidates must be British subjects and at least twenty-one years of age.

Further particulars and application forms may be obtained from the Education Officer (T.S), The County Hall, S.E. 1 (stamped addressed foolscap envelope necessary), to whom the form must be returned by 18th June, 1931.

MONTAGU H. COX,
6931 Clerk of the London County Council.

The Engineer

PRINCIPAL CONTENTS OF THIS ISSUE.
ARRANGED FOR CARD INDEXING.

Montrose Bridge. (P. 615)
THE ENGINEER, 5 - 6 - 31.

The Electrically-Propelled Motor Ship Lochfyne. (P. 623)
THE ENGINEER, 5 - 6 - 31.

Over-voltage Problems. (P. 624)
(A. H. VON ALTMANN.) THE ENGINEER, 5 - 6 - 31.

A New Australian Locomotive Works. (P. 621)
(C. P. JENKYNS.) THE ENGINEER, 5 - 6 - 31.

Bigger Wagons for British Railways. (P. 620)
(F. W. BREWER.) THE ENGINEER, 5 - 6 - 31.

New Fish Dock for Grimsby. (P. 619)
THE ENGINEER, 5 - 6 - 31.

Milling Machine for Tungsten Carbide Cutters. (P. 632)
THE ENGINEER, 5 - 6 - 31.

Research in Industry and Rationalisation. (P. 632)
(DR. A. ENSTRÖM.) THE ENGINEER, 5 - 6 - 31.

INDEX TO ADVERTISEMENTS, PAGE 67.

PUBLIC NOTICES

Armstrong College,
NEWCASTLE-UPON-TYNE.
(IN THE UNIVERSITY OF DURHAM.)

COURSES for the PASS DEGREE of B.Sc. and the HONOURS DEGREE of B.Sc. in MECHANICAL, MARINE, CIVIL or ELECTRICAL ENGINEERING, MINING, METALLURGY, or NAVAL ARCHITECTURE. The curricula of the Pass Degree and the Honours Degree normally occupy periods of three and four years respectively, but candidates presenting evidence of sufficient previous training may be allowed to proceed to either Degree after two years' residence.

The engineering laboratories have recently been extended, and all Departments are equipped for advanced tutorial and research work.

Full particulars of the Courses may be had on application to

THE REGISTRAR,
Armstrong College,
6289 Newcastle-upon-Tyne.

Leicester City Education COMMITTEE.
LEICESTER COLLEGE OF TECHNOLOGY
(L. W. KERSHAW, B.Sc., A.M. Inst. C.E., Principal.)

WANTED, for 1st September, 1931, a FULL-TIME GRADUATE ASSISTANT in the Department of Engineering.

In addition to being in possession of the necessary academic qualifications, applicants must be experienced practical mechanical engineers.

Salary according to the Burnham Scale.

Applications, together with copies of testimonials, should be sent to the Registrar of the College not later than June 23rd, 1931.

F. P. ARMITAGE,
7054 Director of Education.

PUBLIC NOTICES

Bengal Nagpur Railway Company, LIMITED.

The Directors are prepared to receive TENDERS for :—

(A) 406 STEEL ENGINE TYRES.
(B) 4000 COLD-DRAWN WELDLESS STEEL BOILER TUBES and 200 SUPERHEATER FLUE TUBES.

Specifications and forms of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after Thursday, 4th June, 1931.

A fee of 10s. will be charged for each copy of the specification, which is NOT returnable.

Tenders must be submitted not later than Noon on Friday, 19th June, 1931.

The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.

By Order of the Board,
R. GRANT,
7060 Secretary.

Borough of Ilford and Barking TOWN U.D.C.
ILFORD AND BARKING JOINT SEWERAGE COMMITTEE.
JOINT PUMPING MAIN.
CONTRACT NO. 7.

The above Authorities are prepared to receive TENDERS for the CONSTRUCTION of about 2580 YARDS of 30in. CAST IRON PUMPING MAIN, together with all VALVES and SPECIALS, &c., and supported in some lengths of REINFORCED CONCRETE PILING, and other APPURTENANT WORKS. The supply of the cast iron pipes are the subject of another contract.

Plans may be seen and general conditions of contract, specification, quantities and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.

Plans may also be seen at the Council Offices, Barking, or the Town Hall, Ilford.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Monday, June 15th, 1931, endorsed "Pumping Main."

By Order of the Joint Committee of the above Authorities,
ADAM PARTINGTON,
Clerk to the Committee.

Town Hall, Ilford,
1st June, 1931. 7052

PUBLIC NOTICES

Borough of Ilford and Barking TOWN U.D.C.
ILFORD AND BARKING JOINT SEWERAGE COMMITTEE.
JOINT PUMPING MAIN.
CONTRACT NO. 6.
TO IRONFOUNDERS.

The above Authorities are prepared to receive TENDERS from Ironfounders for the SUPPLY and DELIVERY at Barking Railway Station, Essex, of about 1175 TONS of CAST IRON PIPES and SPECIALS. The pipes and specials will be 30in. and 21in. diameter (mostly 30in.) and will be British standard spigot and socket class. They are required in connection with the pumping mains from the Joint Authorities' Pumping Station at Barking Wharf to the London Main Northern Outfall Sewer.

Plans may be seen and general conditions of contract, specification, quantities and form of Tender may be obtained at the office of the Engineers, Messrs. W. H. Radford and Son, Civil Engineers, Albion Chambers, King-street, Nottingham, on deposit of Three Guineas (cheque), which will be returned on receipt of a bona fide Tender and the return of the quantities.

Plans may also be seen at the Council Offices, Barking, or the Town Hall, Ilford.

The lowest or any Tender will not necessarily be accepted.

Sealed Tenders to be delivered to the undersigned on or before the first post on Monday, June 15th, 1931, endorsed "Cast Iron Pipes."

By Order of the Joint Committee of the above Authorities,
ADAM PARTINGTON,
Clerk to the Committee.

Town Hall, Ilford,
1st June, 1931. 7051

Cambridgeshire Education COMMITTEE.
SAWSTON VILLAGE COLLEGE.

REQUIRED for the Senior School in September next, ASSISTANT MASTER to teach MECHANICS and METAL WORK. A fully equipped workshop is being erected. Applicants must have had a good general education and experience of Engines and Electrical Apparatus.

Salary according to qualifications and experience. There will be opportunity for work in connection with Evening Classes, for which additional remuneration will be paid.

Forms of application may be obtained on receipt of a stamped addressed foolscap envelope from the EDUCATION SECRETARY, County Hall, Cambridge. 30th May, 1931. 7053

County Council of the West RIDING OF YORKSHIRE.
SUPPLY OF STORES, FURNITURE, ELECTRICAL EQUIPMENT, &c.

APPLICATIONS are INVITED from persons and firms (particularly manufacturers) for PERMISSION to be PLACED on the LIST of PERSONS and FIRMS from whom the Stores Committee may from time to time invite quotations for various kinds of Stores, such as Printing, Bookbinding, Motor Cartage, Boot Leather and Leather Goods, Brushes for Cleaning, Painting, Chemicals, Drugs, First-aid Appliances, &c., Coal and Coke, Electrical Materials, Engineers' Tools and Stores, Ironmongery, Metals, Hardware, Furniture (School and Office), Varnishes, Colours, Soap, Paper (various kinds), Manufactured Stationery, Office Sundries, Textiles, Clothing, Haberdashery, Timber (Soft and Hard), Provisions and Foodstuffs.

Applications must be made on the official form, copies of which (together with standard conditions of supply), may be obtained from the Stores Manager, County Council Stores, Cliff-lane, Wakefield.

Firms who have already applied and have received acknowledgement of the form need not make fresh application.

J. CHARLES McGRATH,
Clerk of the County Council.
County Hall, Wakefield. 7058

County Borough of Warrington. RESIDENT ENGINEER REQUIRED for Construction of New Reinforced Concrete Arch Bridge near Warrington ; applicant should have had recognised training as a civil engineer, experience in constructional work, inspection, bridge design and surveying is essential. Salary £7 10s. per week.

Applications to be sent to the Town Hall, Warrington, addressed to CHAIRMAN, Paving Committee, before Noon Monday, June 15th. 7070

SITUATIONS OPEN

COPIES OF TESTIMONIALS, NOT ORIGINALS, UNLESS SPECIFICALLY REQUESTED.

WANTED, ASSISTANT ENGINEER for Large Firm of Quarry Owners, applicants to be between 25 and 30 years of age, and to have had an all-round general engineering training, including civil, mechanical and electrical experience. Give full outline of experience and state salary required.

Address, 7062, The Engineer Office. 7062 A

WANTED, ENGINEER MANAGER, with Business ability experience of Pile Driving and Practical Construction Work, able to supervise contracts and interview engineers. Good connection with architect and engineers essential. Applications treated in confidence. State age, if married or single, salary required, qualifications, with copies of testimonials.—Address, 7064, The Engineer Office. 7064 A

SITUATIONS OPEN (continued) Page 2.
SITUATIONS WANTED, Page 2.
PUBLIC NOTICE, Page 2.
AUCTIONS, Page 68.
MACHINERY, &c., WANTED, Page 68.
PATENTS, Page 68.
AGENCIES, Page 2.
FOR HIRE, Page 68
MISCELLANEOUS. Page 2.
EDUCATIONAL, Page 2.
BUSINESSES and PREMISES (For Sale, etc.). Page 68.
FOR SALE, Pages 2 and 68.
WORK WANTED, Page 68.

For Advertisement Rates see Leader Page.

PUBLIC NOTICE

Government of Bombay.

NOTICE.

To IRRIGATION DEPARTMENTS, PORT AUTHORITIES, RAILWAYS, MUNICIPALITIES, ELECTRIC SUPPLY COMPANIES, PUBLIC WORKS CONTRACTORS AND OTHER ADMINISTRATIONS CARRYING OUT LARGE ENGINEERING WORKS.

Notice is hereby given that, owing to the approaching completion of the Lloyd Barrage at Sukkur, large quantities of Plant and Machinery as briefly detailed in the list below will shortly become available for sale. The bulk of the plant will not be available until after June, 1931, but some plant is now available and other plant will become available shortly.

All Administrations who have works in progress or who are contemplating works in the near future are invited to consider the subjoined list and to apply to the undersigned for full particulars and prices of any plant which might be of use to them. Enquiries are NOT invited from machinery dealers at the present stage. Most of the plant was purchased new for these works and is in excellent condition. Every item of plant sold will be first overhauled and put in thorough working order before sale and will be open for inspection (and test, wherever possible) by appointment at Sukkur.

Service will also be given after sale and purchasers' men will be trained by arrangements, as long as the Barrage Construction Works and Shops are in existence.

A. A. MUSTO,
C.I.E., M.I.C.E., I.S.E.,
Superintending Engineer, Lloyd Barrage Circle.

Postal Address: Sukkur, Sind, India. Cables: "SUKBAR, SUKKUR."

LIST OF PLANT & MACHINERY.

RAILWAYS.
About 40 miles of 5ft. 6in. gauge Railway complete and 9 Steam Locomotives and about 700 Wagons of all types, including 20-Ton Either-side Tipping Wagons. About 25 miles 2ft. gauge Railway complete and 15 Kerosine and 2 Steam Locos. and about 1100 Either-side Steel Tip Wagons of 27 cubic feet capacity.

FLEET.
Two Shallow-draught Suction Dredgers, by Lobnitz, 20in. discharge, to dredge to 30ft. each, complete with 1000ft. Floating Pipe Line and Terminal Pontoon with 150ft. overhang at 40ft. above water line.
Also Shallow-draught Paddle and Twin-screw Tugs, Motor Launches, Steel Barges, Pontoons, &c.
NOTE.—All motors on electrically driven plant are for A.C., 400 volts, 3-phase, 50 periods.

CRANES.
25-Ton and 10-Ton Electric Floating Derrick Cranes, 10-Ton and 1½-Ton Electric Derrick Cranes, 20-Ton and 2-Ton Steam Derrick Cranes. Also 5-Ton Steam Loco. Cranes and 10-Ton Electric Loco. Cranes, 5ft. 6in. gauge. Also 15-Ton, 12-Ton and 5-Ton Electric Goliath Cranes, 15-Ton Electric Shop Gantry Crane, and 15-Ton Hand-operated All-round Derrick Cranes.

PUMPS.
Sets of 3in., 4in., 3in.," and 2in. Direct-coupled Electric Centrifugal Pumps for 40ft. head.

PILE DRIVERS.
Floating and Land Sets with McKiernan-Terry Double-acting Piling Hammers, Spencer-Hopwood Boilers, Zenith Winches and Steel Frames and Leads for driving 45ft. Piling.

STONE CRUSHERS.
"Acme" Jaw Crushers, 24in. by 15in., with Elevators, Hoppers and Screens and Portable Crusher, 12in. by 6in.

CONCRETE MIXERS.
Complete Plants for Moulding 10-Ton Blocks with Travelling Mixer Bridge carrying 2-Yard Ransome Mixers complete with Bunkers, Elevators and Batch Measuring Hoppers for materials, all electric driven. Also Steel Moulds for 10-Ton and 1½-Ton Blocks. Also Electric-driven Portable Mixers of sizes.

AIR COMPRESSORS.
Direct-coupled Electric-driven Sentinel Two-stage Compressors of 300 cubic feet capacity. Belt Drive Ditto of 550, 300, 188, and 140 cubic feet capacity respectively. Pneumatic Tools of all kinds.

DIVING GEAR AND DRESSES, &c.

ELECTRIC POWER PLANT.
Following Diesel Engines direct coupled to Alternators generating A.C., 6600 volts, 3-phase, 50 periods :—
2 Swiss Loco. 4-Cylinder Single-acting Diesels, 750 B.H.P., with Fly-wheel Alternator, 500 kW., by Oerlikon.
Metro-Vickers Cubicle Type Switchboard.
Johnson and Phillips Transformers, 6600 to 400 volts, of sizes.
H.T. and L.T. Overhead Transmission Poles, Cables, &c.

MORTAR MILLS.
Both Over-driven and Under-driven Type Mortar Mills, 8ft. dia. pans, with belt drive from countershaft.

WORKSHOP MACHINERY.
Lathes, Shapers, Planers, Milling Machines, Drilling Machines, Belt Air Hammers, Belt Hammers, Punching and Shearing Machines, Forges, Woodworking Machinery, Plate Rolls, Iron and Brass-foundry Equipment, Saw Sharpening Machines, &c.

QUARRY PLANT.
Compressed Air Drills of all sizes, Forging Machines, Oil Furnaces, Air Compressors, Oil Engines, Wire Saws, Channellers, &c.

STONE DRESSING PLANT.
Diamond Saws, Planers, Frame Saws, Rip Saws, Countershafts, &c.

ENGINES.
Oil Engines of various sizes.

BUILDINGS.
Steel-framed Stone Dressing Shop, 360ft. by 115ft., with 15-Ton Gantry Runway and numerous Smaller Steel Roof Trusses, &c.

STEEL SHEET PILING.
About 11,000 Tons "Universal" 15in. by 5in. by 43 lb. per square foot Interlocking S.S. Piling in 40ft., 45ft., and 50ft. lengths.

MISCELLANEOUS PLANT.
Such as Steel Riveted and Sectional Tanks of all sizes, with and without Staging, Winches, Jacks, Pullers, Wire Ropes, Motor Lorries, and many other items.

A. A. MUSTO,
S.E.L.B.C.

MS.13/10. P.B. 40/30. 6445

SITUATIONS OPEN (continued)

WANTED, REPRESENTATIVE for the Sale of Engineers' Stores. Good salary, expenses, commission and car provided to suitable applicant who would invest not less than £500 in business, which would be secured.—Address, P1159, The Engineer Office. P1159 A

A LARGE FIRM of ENGINEERS, Midlands, has VACANCY for PREMIUM PUPIL. Excellent opportunity for youth of character, energy, and engineering aptitude.—Address, 7019, The Engineer Office. 7019 A

CHARGE ENGINEER, with Mechanical and Electrical knowledge, WANTED for a Commercial Laundry with high-class equipment.—Q.R. LAUNDRY, Carlisle-road, Leyton, E. 10. 7067 A

CONSULTING ENGINEERS in Westminster Have OPENINGS for ENGINEERING DRAUGHTSMEN (first class only), accustomed to design and details of Steel Bridge Work. Experience in Reinforced Concrete and Foundations an advantage. State age, salary, and particulars of experience.—Address, 7066, The Engineer Office. 7066 A

LUBRICATING OILS AND GREASES.—SALESMEN, with existing connection, will shortly be REQUIRED to introduce new Oils and Greases that are produced by a patent process and possess distinct advantages over any other lubricants at present on the market. Good commission and reserved territory to approved applicants.—Address, with full details of experience and territory covered, 7071, The Engineer Office. 7071 A

REINFORCED CONCRETE.—SENIOR DESIGNER REQUIRED by Specialist Firm. Previous experience essential. State full particulars of qualifications, experience, with dates, and salary required.—Address, 7069, The Engineer Office. 7069 A

TRAVELLER REQUIRED for Firm Manufacturing G.M. Cocks, Valves and Fittings, also Coppersmithing Work. Preferably young man having own connection.—Address, stating age and experience, P1147, The Engineer Office. P1147 A

WORKS MANAGER and ASSISTANT WORKS MANAGER are REQUIRED for highly progressive Firm of Screw Fan Manufacturers. Well-educated and ambitious men with driving power, initiative, thorough knowledge of modern methods of works production and good organising ability are desired. Progressive and good conditions are available.
Address, stating age, salary required, and experience, 7065, The Engineer Office. 7065 A

£1000 — MANUFACTURER'S SON REQUIRED as REPRESENTATIVE for London in specialised line. Highest references required and given.—Address, P1095, The Engineer Office. P1095 A

DRAUGHTSMAN, Capable, REQUIRED by Large Manufacturing Firm in London district, preferably with knowledge of Woodworking Machinery or Machine Tools.—Address, P1144, The Engineer Office. P1144 A

DRAUGHTSMAN REQUIRED in London, with wide experience in Gear Design and General Transmission Work; essential good mathematician. State full particulars of experience, age, and salary required.—Address, 7072, The Engineer Office. 7072 A

DRAUGHTSMAN WANTED IMMEDIATELY (Midlands), thoroughly experienced in design and arrangement of Elevators, Conveyors, Screens and Structures; must be quick, reliable, accurate, and able to work on own initiative. Permanency for right man.
Address, stating age, experience, and salary expected, 7061, The Engineer Office. 7061 A

SITUATIONS WANTED

B.Sc. (Hons.) (23), Training in Civil, Electrical, mechanical engineering, experience Middle East, REQUIRES POSITION on Sales Organisation at home or abroad.—WIGGINS, Garway Hill, Herefordshire. P1141 B

B.Sc., A.M.I. Mech. E. (31), Engineer and Designer, general engineering, mechanical handling and mining plant lay-out, mech. and struct., SEEKS POSITION, preferably administrative, at home or abroad. Highest references.—Address, P1142, The Engineer Office. P1142 B

ENGINEER and DESIGNER (31), Mech. and Struct., 1st cl. d'man., excellent record, SEEKS RESP. POSITION, with scope and prospects. Available now.—Address, P1155, The Engineer Office. P1155 B

ENGINEER DESIGNER of Overhead Lines, Expert in sag calculations and steel towers, executive and administrative experience, good organiser, WOULD CONSIDER CHANGE.—Address, P1138, The Engineer Office. P1138 B

ENGINEER (36), Extensive Experience of Modern production methods for the manufacture of small accurate mechanisms, electrical and mechanical, used to control of all classes of labour, several years in managerial positions, DESIRES POST as Works Manager or Production Manager.—Address, P1120, The Engineer Office. P1120 B

ENGINEER, Mechanical and Constructional, with long and wide experience, DESIRES ADMINISTRATIVE POST.
Address, P1152, The Engineer Office. P1152 B

ENGINEER, 27 Years of Age, Very Energetic and reliable, urgently NEEDS OPENING where he would have more time to study for I.E.E. exam. Good electrical and mechanical theory and experience in charge of electrical, Diesel, steam and other plant. For the past five years has worked seven days a week.—Address, P1134, The Engineer Office. P1134 B

GOVT. ENGINEER (29), Public School, with Colonial Govt. over five years, carrying out variety heavy construction works and maintenance, steam and Diesel stations, &c. &c., as superintendent, well recommended, OPEN to OFFER suitable EMPLOYMENT abroad from established firm. Details on request.
Address, P1049, The Engineer Office. P1049 B

H. T. THORNE, Chief Engineer to a Leading Aerial Ropeways Company, begs to announce his connection with that company will shortly terminate, and will then be free to accept another APPOINTMENT where his 27 years' ropeway experience could be used to mutual advantage.—Address, P1143, The Engineer Office. P1143 B

MECHANICAL and STRUCTURAL DESIGNING ENGINEER, 3 years' marine, 3½ years' oil refinery, 2½ years' general experience, including reinforced concrete and heating and ventilating.—Address, P1114, The Engineer Office. P1114 B

MECHANICAL ENGINEER, University Degree, British and foreign experience in power production, fluent French and German and some Spanish, single, 29 years, SEEKING POSITION at home or abroad.—Address, P1113, The Engineer Office. P1113 B

MECHANICAL ENGINEER DISENGAGED; Estimating, rate fixing, lay-outs, 7 years last post (3 years chief), engaged on laundry, bakery and wrapping machines and plant, good general experience, practical and technical. Age 48.—Write, J. R., 29, Derwentwater-road, Acton, London, W. 3. P1121 B

SKILLED ENGINEER, 23 Years, SEEKS POST; 6 years' experience leading Diesel and I.C. engine mftrs., erection, maint'nce, fitting and turning, tech. studies, draughtsman certif. Ldn. dist. or Southend.—Address, P1153, The Engineer Office. P1153 B

STRUCTURAL ENGINEER, 12 Years' Experience, testing and inspecting bridge work, locomotive boilers, tubes, general rolling stock, &c., at home and abroad, OPEN to UNDERTAKE INSPECTION CONTRACTS.—Address, P1165, The Engineer Office. P1165 B

SITUATIONS WANTED (continued)

SUCCESSFUL SALESMAN, Fluent Spanish, Portuguese, Italian, thoroughly acquainted South America, Southern Europe, DESIRES REPRESENT GOOD FIRM, any country.—W. PAYNE, 114, Tavistock-road, Plymouth. P1149 B

DESIGNER and DRAUGHTSMAN (30), Experienced in power plant lay-out and detail, boilers, conveyors, and everything appertaining, DESIRES POSITION, London district.—Address, P1161, The Engineer Office. P1161 B

DRAUGHTSMAN (29), London, 3 Years Tech. College, 5 years shops, 8 years D.O., contl. and recip'g. pumps, gears, and general experience. Excellent refs.—Address, P1158, The Engineer Office. P1158 B

YOUNG DRAUGHTSMAN (22), 3 Years Tech. College graduate, 3 years' D.O. experience, SEEKS IMMEDIATE ENGAGEMENT. Knowledge of design, details and quantities. Disengaged. Would suit structural engineer or contractor.—Address, W. J. PARKER, 32, Hartfield-crescent, Wimbledon, S.W. 19. P1150 B

EDUCATIONAL

Correspondence Courses
OF
PREPARATION
FOR THE
Examinations
OF THE
INST. OF CIVIL ENGINEERS.
INST. OF MECHANICAL ENGRS.
INST. OF STRUCTURAL ENGRS.
UNIVERSITY OF LONDON, &c.
ARE PERSONALLY CONDUCTED BY
Mr. Trevor W. Phillips,
B.Sc., Honours, Engineering, London University, Assoc. M. Inst. C.E., A.M.I. Struct. E., M.R.S.I., F.R.S.A., Chartered Civil Engineer, &c.
For full particulars and advice apply to :—
36, DALE STREET, LIVERPOOL.
LONDON OFFICE :—65, CHANCERY LANE, W.C. 2.

Oxford Correspondence College,
BEAUMONT HOUSE, OXFORD.
THOROUGH POSTAL PREPARATION FOR :—
B.Sc. (ENGINEERING), Pass and Honours.
A.M.I.C.E.,
A.M.I.M.E.,
and also Electrical, Structural, Aeronautical, Automobile and Marine Engineering Examinations.
Low fees—payable monthly. 50 Tutors, Individual Attention. Textbooks loaned.
Prospectus from the Secretary.

THE PREPARATION of CANDIDATES for the EXAMINATIONS of the Institutions of Civil and Mechanical Engineers is UNDERTAKEN by Mr. A. EGERTON KIDNER, Assoc. M. Inst. C.E., M.I. Mech. E., 53, Victoria-street, S.W. 1. Victoria 1155. P1161 E

T.I.C.B.
CORRESPONDENCE COURSES
FOR THE
PROFESSIONAL EXAMINATIONS
A.M. Inst. C.E., A.M.I. Mech. E., A.M.I.E.E., etc.

Convincing proof that The T.I.G.B. training is markedly successful is found in the many pages of "The Engineer's Guide to Success" which are filled with typical results of T.I.G.B. Students. This testimony of former Students obviously provides the soundest reason why you too may enrol with The T.I.G.B. with every confidence in the issue

Write to-day for "The Engineer's Guide to Success" — 128 pages — containing the widest selection of engineering courses in the world, and mention the branch, post or qualification that interests you. The T.I.G.B. guarantees training until successful for the one fee.

THE TECHNOLOGICAL INSTITUTE OF GREAT BRITAIN,
76, Temple Bar House, London, E.C. 4
(Founded 1917.)

AGENCIES

ADVERTISERS, with Exceptional Facilities for obtaining overseas business, would be GLAD to HEAR from ONE or TWO MANUFACTURERS in Engineering or Allied Trades DESIROUS of EXTENDING in that direction.—Address, P1148, The Engineer Office. P1148 D

AGENT, with Good Connection, for 30 Years Calling on manufacturers, DESIRES ANOTHER AGENCY; valve maker preferred. Commission only.
Write, Box R375, Lee and Nightingale, Liverpool. P1139 D

AGENTS REQUIRED in the Chief Counties, with first-class connections amongst Steam Users.—Apply, OWENS BOILER CIRCULATOR (1930), Ltd., 57, Victoria-street, S.W. 1. 7027 D

ANY ENGINEERING FIRM which Contemplates giving up its branch or sales organisation in Calcutta can be provided with efficient REPRESENTATION by a British Firm of high responsibility and wide connections.
Established in that city for over a century.
Address, P1116, The Engineer Office. P1116 D

ENGINEERS, Hants Area, Connection with Engineers, architects and transport users, are PREPARED to REPRESENT sound Manufacturers of Steel Work, Tubular Goods and Castings.—Address, P1163, The Engineer Office. P1163 D

LEADING CALCUTTA FIRM, Established Over 100 years, contractors to Indian Government, railways and other public bodies, already representing important British engineering firms, are OPEN to CONSIDER an AGENCY for High-grade Engineering Specialities.
Reply by letter only to JOHN SHAW and SONS, WOLVERHAMPTON, LIMITED, Wolverhampton. P1115 D

LONDON AGENCY.—A FIRM of ENGINEERS, with excellent offices in Victoria-street and live connection, is PREPARED to ARRANGE further AGENCY with a progressive firm requiring London representation.—Address, P1160, The Engineer Office. P1160 D

LONDON ENGINEERING FIRM, with Sound extensive personal connections in London and South, is OPEN to REPRESENT PRODUCERS of Light and Heavy Castings, Plain and Machined; also Heavy Machinery, Chilled and Grain Rolls, and Drop Forgings, who can quote competitive prices.

Write "B. A." care of J. W. Vickers and Co., Ltd., 24, Austin Friars, E.C. 2. P1164 D

FOR SALE, THEODOLITES.
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road).

FOR SALE, LEVELS.
DRAWING INSTRUMENTS, SECOND-HAND.
CLARKSON'S, 338, High Holborn, W.C.
(Opposite Gray's Inn-road). Ex.

MISCELLANEOUS

ENGINEERS—

We offer you the finest and most complete book on Engineering Careers ever compiled—absolutely FREE of charge. This book contains 180 pages of invaluable information and advice. It also contains details of B.Sc., A.M.I.C.E., A.M.I. Mech. E., A.M.I.E.E., A.M.I.A.E., A.M.I. Struct. E., M.R. San. I., L.I.O.B., F.S.I., G.P.O., C. and G., etc., Exams., outlines home-study Courses in all branches of Civil, Mechanical, Electrical, Motor, Wireless, Aeronautical and "Talkie" Engineering and explains the unique advantages of our special Appointments Department. WE ALONE GUARANTEE "NO PASS—NO FEE." You owe it to yourself to read our Handbook. Send to-day, stating branch or subject of most interest.

BRITISH INSTITUTE OF ENGINEERING TECHNOLOGY.
22, Shakespeare House, 29-31, Oxford St., W.1.
P1145 I

FOR SALE

BOILERS, TANKS and AIR RECEIVERS.
New, several 11ft. long by 5ft., Reos. 80 lb. W.P.
Lancashire Boiler, 30ft. by 7ft., 80 lb. W.P.
Cornish Boiler (1915), 24ft. by 6ft. 6in., 80 lb. W.P.
TANKS (Boiler Shells), 30ft. by 8ft., extra heavy.
Ditto 30ft. by 7ft.
H. & T. DANKS (Netherton), LTD.
Boilermakers and Engineers, Netherton, DUDLEY. 5840 c

CASTINGS, Forgings, Discs, Rings, Flanges, Blanks, Component Parts, rough or finished, Machined (in Ferrous and Non-ferrous Metals). Keenest prices.—ELLACOTT ENGINEERING CO., Robert-street, Sheffield. 'Phone and 'grams, 43261. P1151 c

FOR SALE on Behalf of Colonial Railways :—
(A) THREE GARRATT LOCOMOTIVES, 2-8-0 by 0-8-2 type, 4ft. 8½in. gauge, maximum axle load 16 tons, total weight in working order 154 tons 15 cwt., tractive effort 63,344 lb. In excellent condition.
(B) TWO MALLETT COMPOUND LOCOMOTIVES, built by the Baldwin Locomotive Company, U.S.A., 0-6-0 by 0-6-0 type, with tender, metre gauge, maximum axle load 8 tons 14 cwt., weight in working order, engine 49 tons 17 cwt., tender 19 tons 5 cwt., tractive effort 17,236 lb.
(C) SPARE PARTS for the above MALLETT LOCOMOTIVES.
For full particulars apply to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, S.W. 1, quoting 0/Prod. 0280. 7043 c

LANCASHIRE BOILERS FOR SALE, Now Taking out; cheap to save second handling, viz., 30ft. 0in. by 8ft. 3in., Thompson Dished End; also 30ft. 0in. by 8ft. 0in. Holdsworth; not less than 150 lb. W.P.—Apply, A. DODMAN and CO., Ltd., King's Lynn. 7033 c

For continuation of For Sale Advertisements see page 68.

Spencer-Bonecourt Patent Waste Heat Boilers.
Broadway Bldgs., Broadway, Westminster, S.W. 1.

1000 CUBIC FEET OF CLEAN AIR PER MINUTE

is passed by this small Protectomotor Air Filter and Silencer, which is our standard design specially adapted for a particular installation.

The small cost of installation and upkeep of such a unit fades into insignificance beside the immense saving it effects in the wear and tear of machinery, with resulting increase in efficiency.

Protectomotor Air Filters are available for all air-using purposes. For large schemes of ventilation, panels can be provided built up in similar filter units to any required capacity.

PROTECTOMOTOR
99·9% Efficient
AIR FILTER & SILENCER
Dry Fabric Self-Cleaning Type

Write for complete Catalogue.

C. G. VOKES Ltd.,
95-97, Lower Richmond Road, Putney, London, S.W. 15.
Telephone: Putney 5851-2. *Telegrams:* "Vokesacess, Put., London."

A Seven-Day Journal

The Five-Year Plan.

OUR contemporary the *Morning Post* recently published an interview with Mr. C. F. Smith, who has returned lately from a ten months' engagement as organiser and instructor at the Stalingrad Tractor Plant. It appears from the information he provided that the Soviet Five-Year Plan is not working out as satisfactorily as it was hoped that it would. The Stalingrad Tractor Plant was designed and built to produce 154 tractors per working day, and for that purpose was equipped with the most modern automatic machinery. Over 300 specialists from America were employed to set the factory going and instruct the workers. The scheduled production for 1930 was originally 12,000 tractors, being later modified to 5000, but the number actually produced was only 1002. For the present year 50,000 were at first scheduled, but up to the end of March only 1700 were produced. Meanwhile the number of workers has been reduced from 17,000 to 10,000, but even computing with the latter figure the cost per tractor during January and February of this year was over 5000 roubles, or about £530. Mr. Smith is of the opinion that the trouble was caused by the type of workman employed, and, now that most of the American engineers have returned home, the need for competent men will be felt more than ever. Educational methods also appear to be unsatisfactory. The organisation of the factory has been seriously hampered by the breakdown of transport facilities throughout the country, while the materials used have been of poor quality. Mr. Smith declares that the results have been similar in nearly all factories.

A Mineral Transport Users' Association.

WE are informed that a new body, having the title "The Mineral Transport Users' Association," has been registered under the Trade Union Acts. The objects of the new body are—to promote the interests of owners and users of railway and road vehicles engaged in works connected with mineral transport; to defend private owners against encroachment upon their rights by Government Departments or other bureaucratic bodies; and to examine and support or oppose measures which concern those interested in the transport of minerals; to provide facilities for the dissemination of information to Members of Parliament and other persons or bodies in connection with the Association; to give free expert technical and legal advice to members; to investigate questions of the improvement and development of transport and of equipment for loading and unloading of minerals and liquids and to support organisations established for the conduct of technical and industrial research; to establish an information bureau and equip and maintain a library, and generally to collect and tabulate information likely to be of service in promoting the objects of the Association; to examine and prepare schemes for the rationalisation upon voluntary lines of the systems of distribution of privately owned rolling stock and advise members about the formation of district co-operative wagon user units; to undertake, if desired, the collection and payment of railway dues, &c., and, if sufficient support is received, certain classes of insurance; and, finally, to support any charitable or public object which may be for the benefit of the Association. The first President is Captain R. Addy, managing director of the Carlton Collieries Association, and Mr. L. A. Kenworthy has been appointed general secretary.

Shipbuilding Employers' Federation.

THE Shipbuilding Employers' Federation announces that it has been decided that the office of permanent Vice-president of the Federation, a position formerly held by Sir Andrew Duncan, until he left the industry to become Chairman of the Central Electricity Board, in the early part of 1927, shall be revived. Mr. John S. Boyd, M.A., LL.B., who had been secretary of the Federation since that time, has now been appointed to that office, and Mr. Alexander Belch, who has been associated with the Federation for twenty years and has recently been deputy secretary, has been appointed secretary. Since he joined the staff of the Shipbuilding Employers' Federation in 1927, Mr. Boyd has acted as a representative of the shipbuilding industry on several industrial bodies, including the National Confederation of Employers' Organisations. He is a member of the Grand Council and Executive Committee of the Federation of British Industries, and was one of the shipbuilding representatives dealing with the Melchett-Turner report on the new industrial arrangements, which laid the foundation for joint consultation between the Federation of British Industries and the National Confederation of Employers' Organisations on the one hand and the General Council of the Trade Union Congress on the other. He is a member of the Fiscal Policy Committee of the Federation of British Industries, and on several occasions, through the National Confederation of Employers' Organisations, has represented British employers at International Labour Office conferences at Geneva. Mr. Belch, the new secretary, came to London with Sir Andrew Duncan as the latter's chief assistant when the Shipbuilding Employers' Federation was reorganised and its headquarters removed to London. He received his early training in industrial negotiations with Messrs. Biggart, Lumsden and Co., solicitors, of Glasgow, with whom he gained experience in the conduct of the affairs of employers' organisations in connection with shipbuilding and ship repairing, marine and general engineering, bridge building, chemical, and other industries.

The Shannon Power Scheme.

THE resignation of Dr. McLaughlin, the managing director of the Irish Free State Electricity Board, has served to revive the suspicion that there has been friction between the Board and the Cabinet. The Electricity Supply Act of 1927 gave the Board a free hand with a working capital of £2,500,000, but it did not authorise it to borrow on the security of its own assets. Thus, when the Board proceeded to take over large local electrical undertakings, with their outstanding liabilities, the Free State Treasury seems to have grown anxious lest the £2,500,000 limit should be exceeded. Discussions between the Board and the Government apparently led to an agreement about the limitations of the Board's expenditure and obligations, and Dr. McLaughlin's resignation is said to have been the result of subsequent complaints that sufficient promptitude had not been shown in taking action to fulfil the agreement. There is no suggestion that the transactions objected to were not sound business investments. The trouble, it seems, was that the Treasury found itself being hurried on further and faster than it had anticipated without receiving the explicit explanations it is accustomed to extract from ordinary Government Departments. It would appear that if the Board is to secure independence of Treasury control new arrangements must be made. The £2,500,000 provided by the 1927 Act will hardly finance its rapidly extending operations, and now that the public is beginning to gain confidence in the Shannon scheme, the question arises as to whether the Board should not be allowed to go into the open market and raise money on the security of its own assets.

The Patent Office.

THE forty-eighth report of the Comptroller-General of Patents, Designs, and Trade Marks, covering the year 1930, shows that the receipts from patent fees were £498,908, from designs fees £10,821, and from trade marks fees £43,575, as compared with £478,661, £11,759, and £44,975 respectively for 1929. The surplus of receipts over expenditure was £154,545. The number of applications for patents received during the year was 39,359, as compared with 39,898 in 1929. Applications in respect of inventions communicated from abroad to persons resident in this country numbered 2355, as compared with 2449 in 1929, and the number of applications made by women was 495, as compared with 433 in the preceding year. The number of complete specifications filed was 24,993, as against 25,386 in 1929. Throughout the year, the greatest activity in invention was in connection with the chemical and electrical industries. The "Grid" resulted in a noticeable increase in inventions relating to the suspension and insulation of overhead voltage lines, pressure compensating devices in oil-filled cables, high-voltage switches, &c. Applications for patents relating to electric motor control systems showed an increase of 25 per cent. There was marked activity in connection with short-wave wireless telegraphy and telephony, particularly in directional systems depending upon the use of aerials of the beam type. The associated problem of "fading" also received considerable attention. Interesting work was done in connection with the use of ultra-short wave lengths for special purposes, such as that of aiding marine and aerial navigation. The report also shows that the totalisator is being developed along electrical lines by the introduction of some of the features of automatic telephony with a view to rendering the apparatus self-checking and more accurate and speedy.

Electricity on the Farm.

THE electrically-operated farm at East Grinstead has recently been re-equipped by the General Electric Company, in collaboration with the owner, Mr. Borlase Matthews, and on Friday, May 29th, an opportunity was given to a party of visitors to see some of the work that is being done. The farm is, in effect, divided into two parts—the main buildings, in which electricity is applied in dairy and other work, and the experimental section, with a workshop as its centre, where theory is put to a practical test. One of the most obvious advantages of electricity on a farm is its use as an illuminant, and at East Grinstead all the yards and buildings are electrically lighted. The dairy is equipped with dustproof lighting fittings and an electric thermal storage water heater which supplies water for cleaning the milking utensils. The cream separator and butter churn are, naturally, electrically-driven. In the cowshed the latest type of electric milking machine is used, the necessary vacuum being obtained from a pump situated in an adjoining room. An electrical device for curing hay in the stack is one of the most interesting features of the electrical equipment. When a stack is being built, chambers are formed in it so that air can be forced through the hay by means of an electrically-driven fan. The apparatus makes it possible for grass to be cut, carted, and stacked in the same day, and it is claimed that the hay so treated is of a high quality. In another part of the farm the soil is warmed by electricity for the purpose of bringing vegetables to early maturity. Electric cables are laid in lines in the beds and electric current passed through them radiates the necessary heat. Among other experiments that are said to have proved successful is that of increasing honey production by electrically-heating and lighting bee hives.

Haulage Accidents in Coal Mines.

THE Safety in Mines Research Board, which is extending the engineering side of its researches, appointed a committee last year to prepare a scheme for investigating possible methods of reducing haulage accidents in coal mines. The Committee's report has just been published by H.M. Stationery Office. It contains a brief analysis of the incidence of accidents over a number of years and a diagram which brings out strongly the remarkable divergence between districts in the accident rate from haulage operations. Equally remarkable divergence was found to exist between collieries in the same district. In addition, statistical information which has not elsewhere been collected in such small compass is included. The Committee points out that although many haulage accidents occur owing to causes which could only be overcome by a change in human nature, and that for others the best remedy lies in vocational training, there still remains a wide field in which research could usefully be undertaken. Recommendations as to the line such research should take are, therefore, made under the headings: Derailments, runaways, methods and conditions of haulage, and protective equipment.

The International Commission for Air Navigation.

LAST Wednesday, June 3rd, Lord Amulree, Secretary of State for Air, opened the nineteenth session of the International Commission for Air Navigation at St. James's Palace. Twenty-seven nations are represented at the conference, and among the items on the agenda are recommendations with regard to the airworthiness of aircraft. In spite of the fact that meetings of the Materials Committee of the Operational and Materials Subcommission were held in London last November and in Paris in December and April, no unanimous conclusions were reached. The British representatives take the view that the minimum requirements should be such that the widest possible field for the development of a technique suitable to the conditions prevailing in individual nations should be left open. The fear is expressed that if such minimum requirements are not laid down, a restraining influence will be felt in the development of materials and designs for civil aircraft. It is believed that further progress towards a solution of this problem was made at another meeting of the Committee in Paris last week, and that the question may be settled at the present conference. Another question to be discussed at the meeting will concern maps. In this section the measures to be taken to warn aircraft of the existence of structures dangerous to their safety, such as power transmission cables and aerial ropeways crossing large valleys and rivers, will be considered.

A New Water Supply for Athens.

M. VENISELOS, the Archbishop, and many prominent people were present, according to the correspondent of a London contemporary, at the opening ceremony of the new water supply for Athens last Wednesday, June 3rd. Up till now the chief want of the city has been a good water supply for the inhabitants, who, reckoning those living in the suburbs and the Piræus, number nearly one million. A contract was awarded in 1925 to the Ulen Company of New York to carry out improvement works. That company first pumped up sea water to wash the streets and cleaned out the old Roman aqueduct built by Hadrian. The flow from a number of springs was also diverted into the aqueduct, with the result that the yield was increased by 50 per cent. The new works consist of the Marathon Dam, by which the water from two streams is impounded near the village of that name. From this point the water is carried by a tunnel 7½ miles long under Mount Parnes, an aqueduct and an iron syphon to a new reservoir on Tourko Vouno Hill, from which it is distributed. The Marathon Dam is a solid concrete wall 14ft. wide at the top and 154ft. at the bottom, 933ft. long, with a roadway along it. A temporary fountain was started at the Temple of Olympian Zeus, taking its water from the new Marathon reservoir.

Montrose Bridge.

AT the present time, owing to the number of road improvement schemes that are being carried out, many opportunities are offered to engineers to design new bridges. That at Montrose is a case in point. Five years ago, in 1926, the Angus County Council and the Royal Burgh of Montrose jointly came to the conclusion that the old suspension bridge across the South Esk at Montrose, which had stood for nearly 100 years, was inadequate to meet the needs of modern traffic requirements, and tenders were invited for the construction of a new one. In due course the bridge was erected, and in a Journal note in our issue of January 9th this year, we recorded that it had been opened by Mr. Adamson, the Secretary of State for Scotland, on January 3rd. At first sight the new bridge strikes the observer as somewhat unusual, but it is soon realised that it is æsthetically very satisfying, as the photograph reproduced on this page will demonstrate. Designed by Sir E. Owen Williams, K.B.E., M. Inst. C.E., it is constructed entirely of reinforced concrete, even the lamp standards, shades and reflectors being made in that material, which is polished where a reflecting surface is required. While the design as a whole is unusual, especial interest will be found in the methods by which expansion and contraction are permitted.

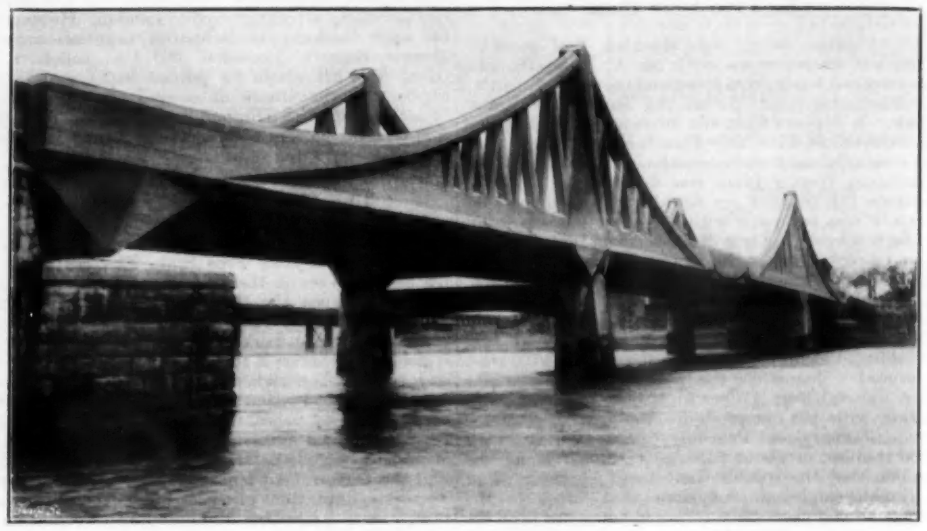
As the new bridge occupies the site of the old one, which had, in consequence, to be demolished before the new one could be begun, a temporary structure had first to be erected alongside. In the photograph, reproduced on page 628, this bridge can be seen. It was constructed of wood and had a roadway 16ft. broad and a footpath 5ft. broad.

By March, 1930, all the preliminary work was finished and the erection of the new bridge was begun. It was expected that it would be completed by November of the same year, but, unfortunately, reliable information as to the material forming the bed of the river was lacking, and difficulties were encountered in finding a secure foundation for the piers. In consequence, the opening had to be deferred until January of this year.

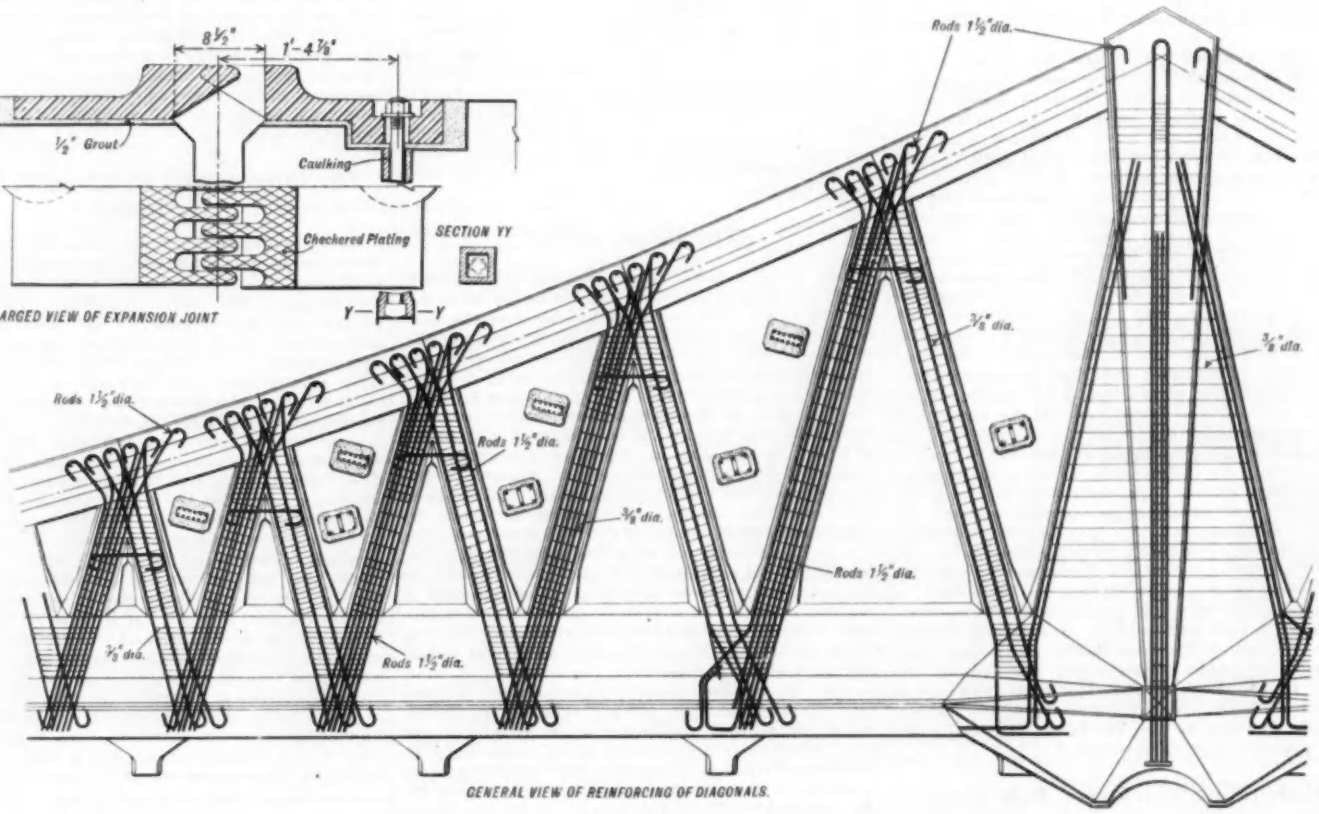
The roadway has a width of 20ft. between kerbs, so that it will accommodate two lines of traffic, and there are two footways each 8ft. wide. The

MONTROSE BRIDGE

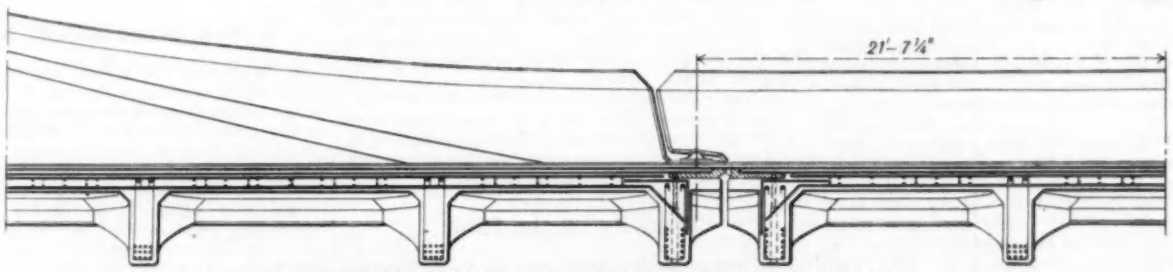
SIR E. OWEN WILLIAMS, M. INST. C.E., ENGINEER



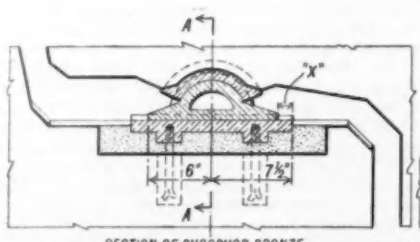
ENLARGED VIEW OF EXPANSION JOINT



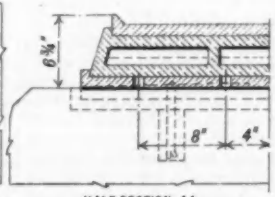
GENERAL VIEW OF REINFORCING OF DIAGONALS.



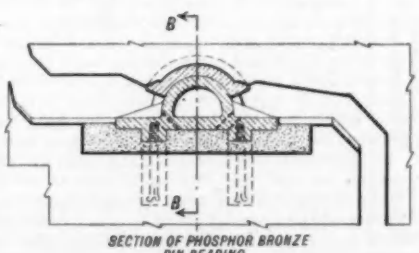
LONGITUDINAL SECTION AT CENTRE OF ROADWAY SHOWING EXPANSION JOINT AT CANTILEVER END.



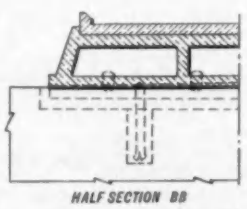
SECTION OF PHOSPHOR BRONZE SLIDING PIN BEARING



HALF SECTION AA.



SECTION OF PHOSPHOR BRONZE PIN BEARING



HALF SECTION BB

centre span is 216ft. in length, and the shore spans each 108ft. The structure is designed to the standard loading specifications of the Ministry of Transport and is capable of carrying a load of 1000 tons over and above its own weight. The contractors for the work were Sir Robert MacAlpine and Sons, the steel was supplied by Dorman, Long and Co., Ltd., and the cement by G. and T. Earle, Ltd. The resident engineers were Mr. H. Iorys Hughes and Mr. A. H. Clark. The cost of the bridge, inclusive of all expenditure, was about £90,000, of which the Ministry of Transport provided 65 per cent.

To provide foundations for the piers on which the cantilevers are supported, steel cylinders, each 22ft. 6in. in diameter, were sunk into the river bed. The material was removed by open dredging, water jets being operated under the cutting edges by divers, and the cylinders were loaded with kentledges of 550 tons. When the driving of the cylinders had been completed, it was found that the foundation would not be sufficiently firm and piles had to be sunk within them. Besides this untoward occurrence, the work was much impeded by the strength of the tide, which, owing to the fact that inland of the site there is a large pool or lake, rushed past the bridge at times at a speed of 8 miles per hour. Before a final decision was reached as to how many piles should be driven and what form, whether round or square, they should take, a number of experiments on the effect of loading, driving and withdrawing piles was carried out. The tests demonstrated that for friction piles of equal perimeter no advantage was to be expected from the use of a circular rather than a square section.

Finally, thirty-two piles 14in. by 14in. and 61ft. long, cast in concrete, were sunk in each cylinder on the south, and an equal number, each 66ft. long, on the north. They were driven into marl overlying limestone rock, either to refusal or to a set of ½in. for ten blows of a 5-ton hammer falling 2ft. The friction force on the piles was found to be 5 cwt. per square foot of surface embedded. Sinking the piles caused each cylinder to rise about 3in., while the "muck" inside rose 4ft. The "muck" was cleared away by divers, a seal of concrete was deposited, and the water was then pumped out without difficulty. Mass concrete was placed inside up to river bed level and hollow piers were built up to a height above high water level. The cylinders, which were, of course, built in sections, were then flooded, and having been unbolted at river bed level, were removed.

The engravings on page 628 show later stages in the work. The abutments of the old bridge were used as the shore supports of the new bridge, and it is interesting to note that when, during the preliminary work, the towers of the old suspension bridge were destroyed, the abutments rose about ¼in. Another structure of some interest was found when the approach roads were being formed. Several feet below ground level it was discovered that the abutments were connected to the anchoring by concrete beams, which appear to have been intended to act as struts.

The drawings and engravings demonstrate sufficiently the main constructional arrangement of the bridge. In the "triangulated" part, the form of the top boom follows closely the shape of the bending moment diagrams for a line load at the centre of the bridge. Seventy-eight bars each 1¼in. in diameter form the reinforcement of this boom. The bars embedded in the "hangers" and the method of connecting them with those in the booms are shown on page 616. The cross beams supporting the roadway vary in section both vertically and horizontally, in accordance with the stresses.

The means provided for taking up expansions and contractions due to changes of temperature are, as already mentioned, of very considerable interest. Reference to the illustrations will show that at the abutments the bridge is supported on a mass of concrete triangular in section forming a shoe, the bottom angle of which is flattened to slide on a flat on the upper surface of the abutment. It was found necessary to insert a number of steel rods connecting the shoes to the abutments; but these rods are free to move in tubes which are filled with a mixture of pitch and wax. It is expected that in the course of time relative movement at this point will be impeded or possibly prevented altogether by the collection of dirt and the effects of wind and weather. To allow for this occurrence the main piers have been made sufficiently slender to flex if any side thrust is thrown upon them, while their upper surfaces are made in the form of half-rollers fitting into cups at the base of the central columns of the cantilevers, so that relative angular movement is possible. The actual "bearings" are formed by grouting phosphor bronze sheets into the concrete.

In the drawing opposite the pin joints on which the "junction span," between the two cantilevers, rests can be seen. One of these is an ordinary pin joint, but in the other provision is made for the pin to slide. At all the sliding points the junction at the road surface is made by means of steel finger plates, which are also illustrated in the drawing.

Since the removal of the centering a very complete record of the movements of the bridge has been kept, and below we tabulate some of the readings obtained.

The readings in Tables I.-IV. show the alterations in the levels before and after removing the centering and the movements since that date. The readings in Table I. refer to levels at the points marked with crosses on the plan view of one of the cantilevers, while those in Table II. were taken at the outer ends in the positions marked by the letter A. Readings of the angular movement of the piers were only taken at the times when the centering was struck; the readings are given in Table III., and refer to the movement x shown. Marks were inscribed on the piers a few feet below the points of support and readings of the movement found here are included in Table IV.

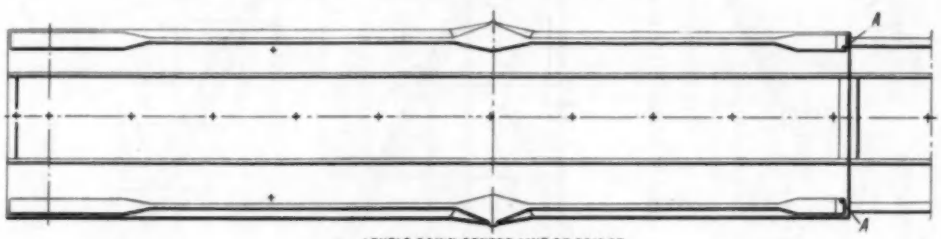


TABLE I.—*Plan at Deck Level.*

Levels taken at spots indicated thus + in plan above.

Date.	North span.												
29/10/30	17·455	17·48	17·54	17·77	18·41 18·45	17·94	18·15	18·39	18·59	18·75	18·905	19·27	19·25*
3/11/30	17·44	17·47	17·54	17·78	18·43 18·47	17·955	18·16	18·38	18·55	18·68	18·78	19·03	19·01†
7/11/30	17·45	17·47	17·54	17·78	18·43 18·47	17·95	18·16	18·38	18·55	18·67	18·78	19·015	19·005‡
	South span.												
29/10/30	17·46	17·47	17·625	17·80		18·00	18·15	18·49	18·63	18·74	18·91	19·175	19·25*
3/11/30	17·45	17·48	17·65	17·82		18·02	18·17	18·47	18·58	18·65	18·76	18·91	19·02†
7/11/30	17·46	17·475	17·65	17·83		18·025	18·16	18·47	18·58	18·66	18·765	18·93	19·015‡

REMARKS.—*North span*: * Taken day before striking started. † Taken immediately after striking completed. All paving complete, no Tarmac. † Taken four days after striking completed. Same dead load. *South span*: * Taken day before striking started. † Taken immediately after striking completed. All paving complete, no Tarmac. ‡ Taken four days after striking, same dead load.

TABLE II.—*Levels on Ends of Cantilevers.*

Levels taken at spots indicated by "A" in plan above.

North span.			Remarks.	South span.			Remarks.
Date.	E. side.	W. side.		Date.	E. side.	W. side.	
29/10/30	19·79	19·78	Taken day before striking started	29/10/30	19·83	19·85	Taken day before striking started
30/10/30	19·755	19·76	Taken during first day of striking	3/11/30	19·69	19·715	9.30 a.m., supported span clear
31/10/30	19·72	19·72	Taken in a.m. of second day of striking	3/11/30	19·625	19·645	11.45 a.m., slacking wedges in progress
31/10/30	19·71	19·715	Taken in p.m. of second day of striking	3/11/30 5/11/30	19·58 19·575	19·60 19·60	3 p.m., all centering clear Two days after striking
3/11/30	19·65	19·67	9.30 a.m., supported span clear	9/11/30	19·58	19·60	Four days after striking
3/11/30	19·61	19·62	10.45 a.m., slacking wedges in progress	10/11/30	19·565	19·585	Main coat Tarmac laid, 2½in. thick
3/11/30	19·57	19·58	11.30 a.m., all centering clear	14/11/30	19·54	19·57	3in. Tarmac on S. spans, 2½in. on supported span
3/11/30	19·56	19·57	3 p.m.				
4/11/30	19·56	19·57	One day after striking	15/11/30	19·55	19·575	3in. Tarmac on S. spans, 2½in. on supported span
5/11/30	19·56	19·57	Two days after striking				
7/11/30	19·545	19·565	Four days after striking	25/11/30	19·54	19·57	3in. Tarmac on whole bridge
10/11/30	19·545	19·56	Seven days after striking				
14/11/30	19·53	19·54	3in. Tarmac on cantilever span, 2½in. on shore span, 2½in. on supported span				
15/11/30	19·53	19·545	3in. Tarmac on N. spans, 2½in. on supported span				
25/11/30	19·53	19·54	3in. Tarmac on whole bridge				

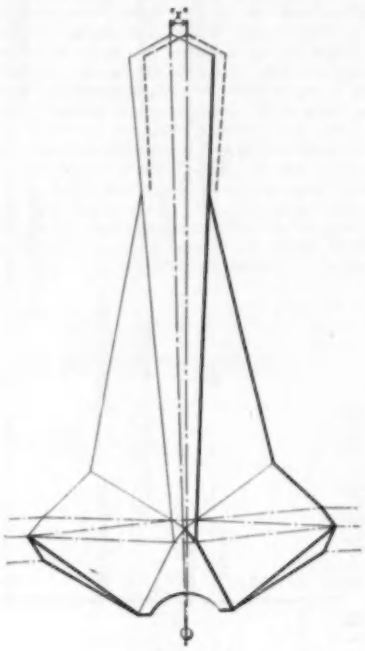


TABLE No. 3.

Main Tower	"X"
N.E.	½"
N.W.	⅛"
S.E.	1/16"
S.W.	5/16"

TABLE IV.—*Levels on Piers.*

Date.. ..	28/10/30.	30/10/30.	7/11/30.	8/11/30.	15/11/30.
N.E. pier..	6·71	6·715	6·715	—	6·71
N.W. pier	6·75	6·76	6·76	—	6·74
S.E. pier ..	6·765	—	—	6·76	6·73
S.W. pier..	6·81	—	—	6·77	6·785

The "breathing" of the bridge with temperature is shown in Table V. The readings refer to the dimension x shown on the drawing of the sliding pin bearing.

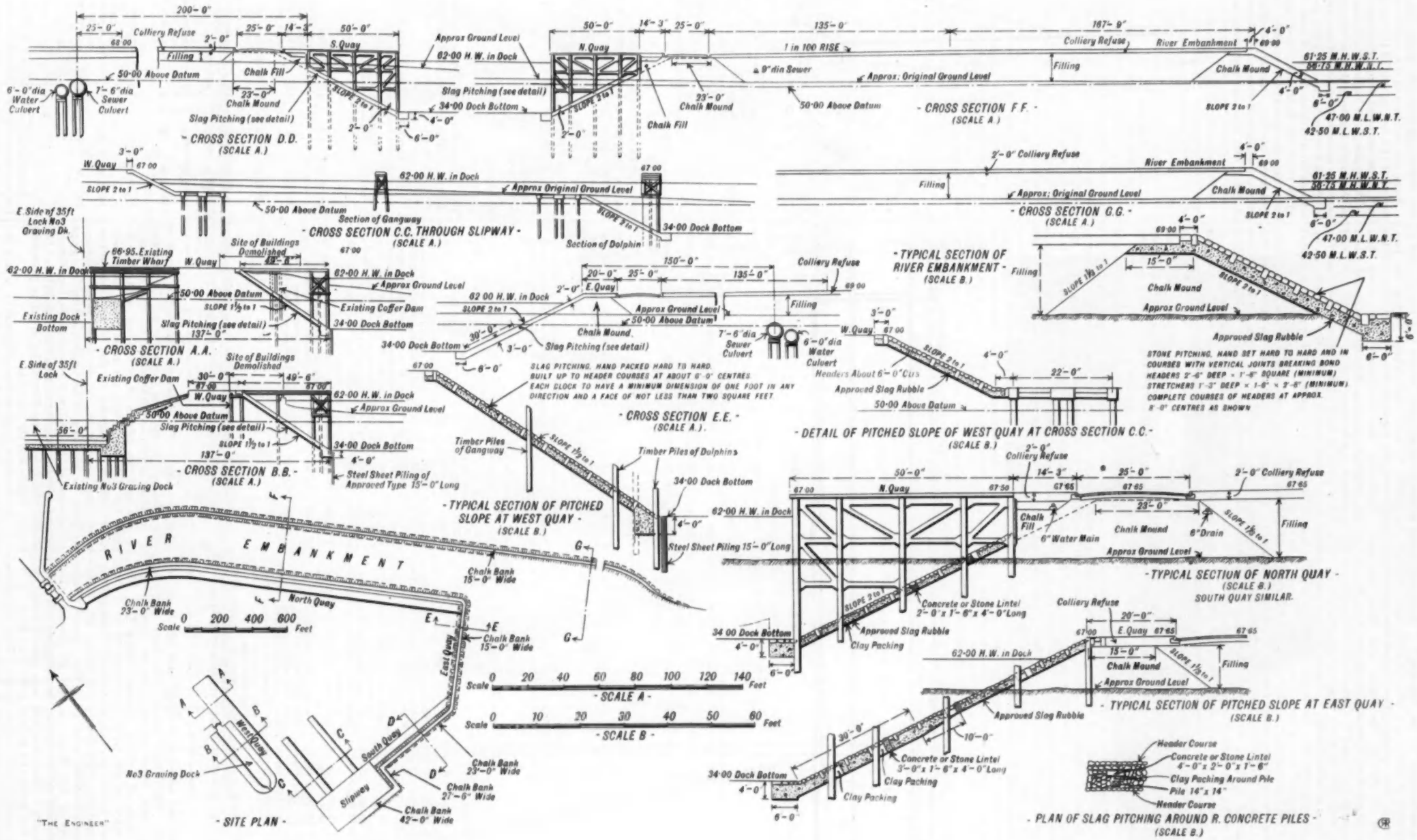
TABLE V.—*Effects of Temperature Changes.*

Date.	Dimension x.		Remarks.
	E. side.	W. side.	
	in.	in.	
29/10/30	1 3/16	2	Before striking centering, mean temperature for previous seven days, max. 55 deg., min. 45 deg.
31/10/30	1⅛	1 11/16	Striking in progress. Frost on night of 30th, min. temperature 29 deg.
7/11/30	1 3/16	1⅛	Striking complete. Mean temperature for previous three days, max. 42 deg., min. 26 deg.
8/11/30	1⅛	1 11/16	Weather freshens on night of 7th. Max. 48 deg., min. 34 deg.
10/11/30	1⅛	1 11/16	Temperature on 9th, max. 54 deg., min. 39 deg.
11/11/30	1⅛	1 11/16	Temperature on 10th, max. 46 deg., min. 38 deg.
13/11/30	1 3/16	2	Temperature on 12th and 13th (mean), max. 54 deg., min. 45 deg.
17/11/30	1⅛	1 3/16	Temperature on 15th, 16th and 17th (mean), max. 43 deg., min. 28 deg.
18/11/30	1 1/16	1⅛	Temperature on 17th, max. 37 deg., min. 25 deg.
25/11/30	1 1/16	1⅛	Mean temperature for previous seven days, max. 45 deg., min. 36 deg.

Æsthetically, reinforced concrete is a material for constructing bridges which has much to be said in its favour, and in this instance it has, we are informed, the added advantage that it involved a considerable saving in first cost.

NEW FISH DOCK FOR GRIMSBY

(For description see opposite page.)


- CROSS SECTION A.A. (SCALE A.)
- CROSS SECTION B.B. - (SCALE A.)
- CROSS SECTION C.C. THROUGH SLIPWAY - (SCALE A.)
- CROSS SECTION D.D. (SCALE A.)
- CROSS SECTION E.E. - (SCALE A.)
- CROSS SECTION F.F. - (SCALE A.)
- CROSS SECTION G.G. - (SCALE A.)
- TYPICAL SECTION OF RIVER EMBANKMENT - (SCALE B.)
- DETAIL OF PITCHED SLOPE OF WEST QUAY AT CROSS SECTION C.C. - (SCALE B.)
- TYPICAL SECTION OF PITCHED SLOPE AT WEST QUAY - (SCALE B.)
- TYPICAL SECTION OF NORTH QUAY - (SCALE B.) SOUTH QUAY SIMILAR.
- TYPICAL SECTION OF PITCHED SLOPE AT EAST QUAY - (SCALE B.)
- PLAN OF SLAG PITCHING AROUND R. CONCRETE PILES - (SCALE B.)
- SITE PLAN -
- SCALE A -
- SCALE B -
RIVER EMBANKMENT
North Quay
West Quay
South Quay
East Quay
Slipway
No3 Graving Dock
Existing No3 Graving Dock
E. Side of 35ft Lock
Existing Coffer Dam
Existing Dock Bottom
Site of Buildings Demolished
Chalk Bank 23'-0" Wide
Chalk Bank 27'-6" Wide
Chalk Bank 42'-0" Wide
Chalk Bank 15'-0" Wide
SLAG PITCHING, HAND PACKED HARD TO HARD. BUILT UP TO HEADER COURSES AT ABOUT 6'-0" CENTRES. EACH BLOCK TO HAVE A MINIMUM DIMENSION OF ONE FOOT IN ANY DIRECTION AND A FACE OF NOT LESS THAN TWO SQUARE FEET
STONE PITCHING, HAND SET HARD TO HARD AND IN COURSES WITH VERTICAL JOINTS BREAKING BOND
HEADERS 2'-6" DEEP × 1'-8" SQUARE (MINIMUM)
STRETCHERS 1'-3" DEEP × 1-6" × 2'-6" (MINIMUM)
COMPLETE COURSES OF HEADERS AT APPROX. 8'-0" CENTRES AS SHOWN
Header Course
Concrete or Stone Lintel 4'-0" x 2'-0" x 1'-6"
Clay Packing Around Pile
Pile 14" x 14"
Header Course
"THE ENGINEER"

New Fish Dock for Grimsby.

As we briefly announced at the time, the initiation ceremony in connection with the starting of a new fish dock at Grimsby took place on November 5th, 1930. The fish trade of Grimsby has for years been of a progressively increasing character. Eighty years ago, only just over 450 tons of fish were landed there during the twelve months. To-day, the annual landing reaches 200,000 tons, or more. From a brochure which was prepared for the initiation ceremony, we learn that the fish goes all over the country—to places as far remote as Rothsay, Penzance, Folkestone, Brighton, North and South Wales, Ireland, France and the Channel Islands, some 7,000,000 packages being annually distributed to 3200 different stations. The quantity of ice which it is necessary to supply to the fishing fleet for preserving the fish on the way from the fishing grounds to port amounts to, approximately, 250,000 tons per annum. It is produced in three local factories. As many as some 600 fishing vessels, including 500 steam trawlers, are registered at the port, and the steamers—trawlers, seine net and liners—consume no less than 900,000 tons of coal per annum. It may be said, therefore, that it takes nearly 5 tons of coal to catch and land 1 ton of fish. There are two coal hoists on the east side of what is known as No. 2 Fish Dock, and by means of them the fuel is shipped into lighters, owned by various coal syndicates, for transference thence to the fishing vessels. In addition to the staple fishing industry of the port, there is an annual herring season lasting from the middle of August to the end of October. The herrings are landed from steam drifters in the Tidal Basin—see the accompanying engraving—and distributed thence for inland consumption or exported to the Continent as required. It will be realised, therefore, that Grimsby's fishing trade is of very considerable proportions.

At the present time there are five docks at the port, *i.e.*, Fishing Docks Nos. 1 and 2, and the Royal, Alexandra and Union Docks, the last three being for general trade and passenger traffic The whole dock system, which is owned by the London and North-Eastern Railway Company, extends to about 104 acres of deep water and 450 acres of land immediately adjoining the quaysides. The length of quayage is more than 22,000ft., while the floor area of the warehouses and transit sheds is in excess of 490,000 square feet, and there are more than fifty portable hydraulic, electric, steam and hand-operated lifting devices. Single weights up to 60 tons can be handled. The port is, therefore, well equipped, but, for all that, it has been recognised for a long time now that an extension of the facilities for dealing with the fishing trade were vitally necessary. As long ago, indeed, as 1912, the then Great Central Railway promoted in Parliament a Bill seeking for powers to construct an additional fish dock, but the war caused the project to be temporarily abandoned. At the end of the war, the need for additional accommodation had become very keenly felt, but as the cost of constructing a new dock had risen from the £500,000 of the estimate of 1912 to £1,250,000, the railway company could not see its way to proceed with the scheme. So the matter was again allowed to drop for the time being. As the result, however, of representations made to it by the Corporation of Grimsby and the trawler owners, the London and North-Eastern Railway Company—into which the Great Central Railway was absorbed in 1923—suggested to the Corporation that, if it would build a dock, borrowing the money for the purpose, the company would undertake to pay a rent for the dock equivalent to the annual payments for interest and sinking fund raised, the understanding being that, when the loan had been finally repaid, the company would take over the dock from the Corporation.

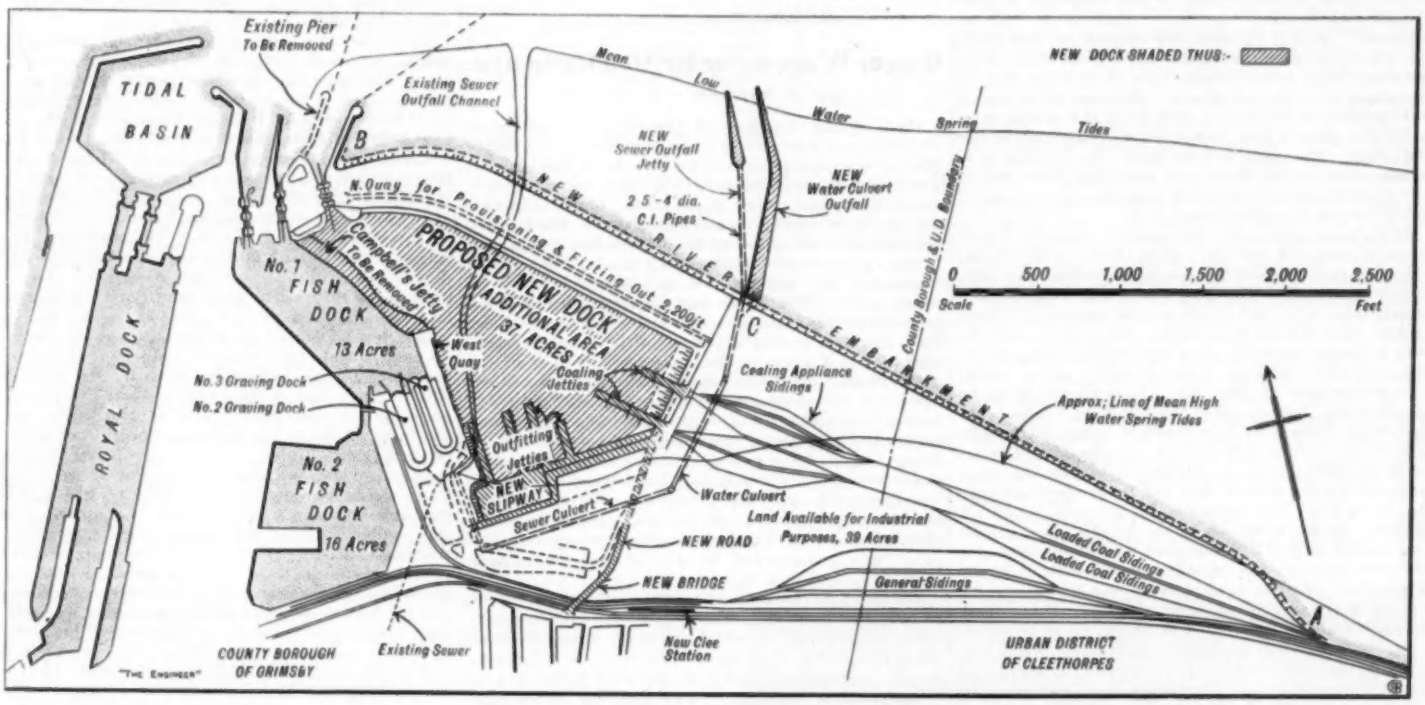
This proposal was adopted, and the Corporation obtained parliamentary sanction to carry out the work by an Act which was passed in 1929. The late Mr. J. A. Wickham, M. Inst. C.E., M.I. Mech. E., the then chief engineer for docks of the L. and N.E. Railway Company, got out the plans and designs for the new dock, and would have acted as engineer during construction, but for his sudden death in April, 1930. He was assisted in his work by Mr. A. Tulip, M. Inst. C.E., who succeeded him as chief engineer for the L.N.E.R. docks. Sir John Wolfe Barry and Partners were subsequently appointed the engineers for carrying out the work. A grant was obtained from the Government towards payment of interest on the loan, the object being to assist unemployment and the absorption of unemployed from distressed areas.

The Act empowered the Corporation to construct and equip a dock 37 acres in extent which will lie alongside and virtually constitute an enlargement of Fish Dock No. 1, the combined area of the two being 50 acres. At the present time, Fish Dock No. 1 is bounded on its north-east—or river—side by what is known as Campbell's jetty, and the works recently begun include the removal of part of that jetty so as to convert the water surfaces of the two areas into one. The new dock will be formed by the building of a river embankment some 6800ft. long from a point—see A on the engraving—to the eastward of the town and well within the Urban District of Cleethorpes, to a point—see B—near the end of the existing Campbell's jetty. The north-east wall of the new dock will be formed by an embankment, which will, for the greater part of its length, be approximately parallel with the river embankment and at a distance of some 340ft. from it. Further embankments will be needed to form the south-east and south walls of the new dock. The construction of the river embankment will result in the reclamation of a large acreage of land, some of which will be required for the railway sidings necessary under the new scheme, though as many as 39 acres will be made available for industrial development.

The cores of the embankments will be composed of chalk mounds, the chalk being quarried at Brocklesby, some 10 miles away, and brought to the site by rail. The mound of the river embankment will, for a very great portion of its length, be about 60ft. wide at the bottom, though its width will be considerably reduced where it approaches the shore at the point A. The mound will taper upwards for a height of some 14ft. to a flat top, 15ft. wide. The side towards the river will be given a slope of 2 to 1, the slope of the landward side being 1½ to 1. A typical cross section of this embankment is given in one of the drawings on page 618. It will be seen that the face of the slope is protected, first of all, by a layer of slag rubble, which will be taken down below the ground level for a depth of some 6ft., where a toe, 6ft. wide by 6ft. deep, is to be formed. The riverward face of the slag will, in its turn, be protected by stone or concrete block pitching set in course, with vertical joints breaking bond, with headers having minimum dimensions of 2ft. 6in. deep and 1ft. 6in. square, and stretchers with minimum dimensions 1ft. 3in. deep by 1ft. 6in. by 2ft. 6in. The complete courses of headers are to be set at approximately 8ft. centres apart, and the combined depth of slag, rubble, and stone pitching is to be 4ft. Then a layer of slag rubble will be continued over the flat top of the mound to a depth of 2ft., and the stone pitching will be continued for a width of 4ft. horizontally over its riverward edge, the elevation at that point being 69·0 above Dock Datum, which is 50ft. below Ordnance Datum. The top of the slag toe will also be pitched at ground level for a width of 6ft. The embankment which will form the north-east wall of the new dock—or, as it will be called, the North Quay—will be constructed in the same way as the river embankment—that is to say, with a core of chalk—and will have the same outer and inner slopes, the outer slope, of course, being that fronting the new dock. The width at the top will, however, be 23ft., instead of 15ft. The space between the two mounds will be filled in up to level 67·0ft. above Dock Datum, or for a depth of some 17ft., with the material excavated from the site of the new dock. The remainder of the reclaimed land will also be filled in. Over the top of this filling material on the quays will be laid 2ft. depth of colliery refuse, so that the ground level, which is to have an upward slope riverwards of 1 in 100, will, where it joins the stone pitching on the top of the river embankment, like the latter, be taken up to 69·0ft. above Dock Datum.

The cross section F F at the right-hand top corner of page 618, which is taken on the line F F in the site plan on the same page, shows both chalk mounds and also the formation of the North Quay. A typical cross section of this quay and its mound is also given to a larger scale on the same page. As will be observed, the former, which is to be 50ft. wide, is to be carried on five rows of piles. These piles, which are to be of reinforced concrete, 16in. by 16in. and 14in. by 14in., will be driven at 12ft. 6in. centres apart along the length of the quay to a depth of some 40ft. to 60ft. The piles will be braced transversely with reinforced concrete struts, as indicated in the drawings, while the longitudinal bracing will also be of reinforced concrete. The horizontal uppermost struts will be arranged flush with the tops of the piles, and will carry the decking of the quay, which is to have a slope dockwards of 6in. in its width of 50ft. The spaces between the rearmost piles will be closed at the back at the top by means of slabs of concrete, the lower edges of which will be taken down into the chalk of the mound, the triangular space thus formed being filled in with chalk. At a distance of 3ft. up-slope from each pile is to be a concrete or stone lintel, 2ft. by 1ft. 6in. by 4ft. long, and the spaces between these lintels and the piles are to be packed with clay. Riverward of the quay at a distance of 14ft. 3in., there is to be a cambered roadway, 25ft. wide, the major portion of the width of which will come directly over the top of the chalk mound.

The North Quay is to be 2200ft. long, and branching south-westward nearly at right angles from its eastern end is to be the East Quay, which is to be 500ft. long. Sections of it are also given on page 618.



EXISTING AND PROPOSED NEW DOCKS AT GRIMSBY

This quay, like the others, is to be founded on a chalk mound with outer and inner slopes of 2 to 1 and 1½ to 1 respectively. The quay deck is to be carried on five lines of concrete piles, arranged at somewhat different distances apart transversely from those carrying the North Quay. There will be this difference, too, that the top of the dockward slope will actually come over the chalk mound, and that there will not be the stop slabs and chalk filling that there are in the North Quay. There is to be a cambered roadway, 25ft. wide, arranged 20ft. from the back edge of the quay deck, this road making junction with the roadway along the North Quay at the east corner of the dock.

Branching almost due westward from the south-western end of the East Quay is to be what will be called the South Quay, which is to be 670ft. long and the westward end of which will terminate in a slipway yard, which will be capable of taking ten vessels at the same time. This quay, like the others, will be founded on a chalk mound. The construction of the quay and its mound is clearly shown in the drawing —section D D at the left-hand top corner of page 618 —so that it calls for no further description. A section through the slipway is also given on the same page—section C C.

Running out into the dock at right angles at the far side of the slipway is what is to be known as the West Quay, which actually is the landward portion of Campbell's Jetty, which is to be allowed to remain, though several modifications will be made to it. Cross sections of it are given in sections A A and B B on page 618. The remainder of the length of Campbell's Jetty, that is to say, from the spur at the end of the West Quay to just to the eastward of the eastern lock leading into No. 1 Fish Dock, will be removed. As will be seen, the removal of this jetty will throw the new dock into No. 1 Fish Dock, with the result that a total water area of 50 acres will be provided, as explained above. Another work which will be removed will be the riverward end of what now forms the eastern pier protecting the entrance to the 35ft. lock. Its place will be taken by another protecting pier, to be known as the East Pier, which will be built out into the river from the north-western end of the river embankment.

At the present moment there are two locks by which access is obtained into No. 1 Fish Dock. These locks, which are parallel with one another, are 30ft. and 35ft. wide respectively. The new works will comprise the construction of a third lock to the eastward of and parallel with the existing locks. The new lock is to have a length between inner and middle gate sills of 70ft., a width between walls of 45ft., and a width between fenders of 42ft. 8in. It is therefore to be considerably larger than the existing locks. At M.H.W.N. there is to be a depth of water on the sills of 21ft. 9in., while at M.H.W.S. the depth will be as much as 26ft. 3in. A channel covering the area indicated by the dotted lines will be dredged out into the river from the entrance to the new lock. A further pier, to be known as the Middle Pier, will be constructed to join the westward wall of the new lock with the base of the existing pier, which is to be demolished. At the inner ends of the lock are to be formed quays which will be known as the Inner West Knuckle and the Inner East Knuckle, respectively.

The existing ground level of the foreshore which is to be reclaimed is about 54ft. above Dock Datum, or about 4ft. above Ordnance Datum, and the new dock will involve the excavation of material at least 20ft. deep over its whole area. The highest water in the dock will be 62ft. above Dock Datum, or 12ft. above Ordnance Datum, the maximum depth of water in the dock being 28ft.

Works for the new dock will include the formation of two coaling jetties, one 238ft. long and the other 400ft. long, and of two outfitting jetties, one 270ft. long and the other 400ft. long. Lines of timber pile dolphins will also be formed (*a*) along the east side of the West Quay; (*b*) between the two slipways; and (*c*) to the east side of the east slipway.

At the present time the sewage and storm water of the town are discharged into an open channel running almost due north from a point at the rear of Graving Dock No. 3 in No. 1 Fish Dock, the point of discharge being approximately at the line of mean high water of spring tides. The course of this channel may be seen in the engraving herewith. A considerable improvement in this direction is included in the new works now under construction. Two new sewers, 7ft. 6in. diameter and 6ft. diameter, are to be connected to two existing sewers, and are to convey the sewage and storm water separately in the directions shown in the engraving, so as to pass through the river embankment at the point marked C. Just beyond the embankment the storm water sewer will discharge into a channel dredged in the foreshore to a point beyond the line of mean low water of spring tides. The sewage outfall will be taken on a jetty for a distance of some 950ft. beyond the embankment, where it, too, will discharge into a dredged channel, which is also to be taken down to beyond the line of mean low water of spring tides. Float experiments have, we understand, indicated that sewage discharged at these points will be taken right away from the shore, not to return, and these alterations should certainly have a beneficial effect on the sanitation of the town.

The scheme also includes the formation of a very considerable length of new railway sidings, which it is only possible to indicate in outline in the engraving. We may explain, however, that in the "Coaling Appliance Sidings" leading to the coaling jetties there will be room for 355 full and 362 empty wagons; in the "General Sidings" there will be room for 1785 wagons; in the "Loaded Coal Sidings" there will be room for 1190 wagons, while there will be room for further wagons in other parts. Special coaling appliances are also to be provided for transferring the coal from the trucks into the vessels. Further works to be carried out are the formation of a road leading to the new dock land, to make junction with the roads already mentioned, which will include the construction of a bridge over the railway.

The parliamentary estimate for the cost of the work was £1,418,000, but the limit of the money to be found by the Corporation is £1,250,000. Any further funds required will be provided by the L. and N.E. Railway Company. An agreement was entered into between the Corporation and the L.N.E.R., which provides that the dock, on completion, shall be leased to the railway company for a period of thirty years. The capital expended by the Corporation is to be repaid by the railway company in half-yearly instalments.

A contract for the main portion of the work has been placed with Sir Lindsay Parkinson and Co., Ltd., the contract time being about 3½ years.

In conclusion, we desire to tender our thanks to Messrs. Sir John Wolfe Barry and Partners for supplying us with much of the material from which the foregoing article has been prepared, and for the drawings from which the illustrations which accompany it have been reproduced.

Bigger Wagons for British Railways.

By F. W. BREWER, A. Inst. Loco. E.

ONE of the findings of the Royal Commission on Transport was to the effect that the use of larger railway wagons in this country should be encouraged. The point arises, therefore, not only as to what is meant by the somewhat vague term "larger wagons," but also as to what type and size of goods and mineral vehicles are best suited to British trading conditions.

The question as a whole is not a new one; it has frequently been debated. So far, however, as recent times are concerned, it was brought into especial prominence some six or seven years ago by Sir Felix Pole, the then general manager of the Great Western Railway, and quite lately, by reference to it in the daily Press. Sir Felix issued an appeal to colliery owners and coal merchants connected with the G.W. Railway to make use of wagons having a bigger load capacity than those commonly employed. These larger wagons were generally taken to be 20-tonners, many examples of which the Great Western authorities themselves had for a long time adopted, chiefly for the conveyance of coal for the purposes of their own locomotives. The action thus taken by the company was commended by the Royal Commission in its third and final report.

Involved in the general problem, of course, is the one concerning the wider use of high-capacity vehicles properly so called, or those having a load-content of 30, 40 or 50 tons. This is not at all an easy matter to determine, and in order to appreciate its complexity, it is necessary to consider it in the light of past experience, and from an impartial standpoint. To begin with, such wagons would not constitute a novelty in British practice. They were in use over 30 years ago, principally, at first, on the Caledonian Railway, and were, in this case, of 30 tons capacity. Wagons having the same, or a greater, load-content, were shortly thereafter brought into use on most of the principal lines, including the North British, North-Eastern, Great Northern, Lancashire and Yorkshire, the Midland, Great Central and Great Western. By 1902, the North-Eastern, in particular, possessed a fairly large number of 40-ton all-steel, double-bogie, mineral wagons, and special vehicles holding a similar load were also introduced on the Great Central Railway in 1904, and on the Great Western Railway in 1905. Later, bogie wagons of as much as 50 tons capacity were put into service for the Fletton brick traffic of the Great Northern line, and only last year the London and North-Eastern Railway built some additional vehicles of this load-content at the Darlington works for the same purpose, and others for the conveyance of sulphate.

These several instances indicate that the railway companies have for a long period utilised large wagons, ostensibly, whenever it has been possible to do so with advantage. Needless to say, it is self-evident that for certain classes of traffic and in certain circumstances, the high-capacity vehicle is an economical proposition. Nevertheless, it clearly has had, and may continue to have, a more or less restricted sphere of usefulness in Great Britain. In this connection, it may be pointed out that the average load per wagon—coal and other special items excepted—is well known to be less than 5 tons; often, it is only 3 tons. Consequently, as the tare weight unavoidably augments with the increase in load-content, it would not be a sound policy to haul these small loads in any but four-wheeled wagons. The double-bogie vehicle, which apparently becomes necessary for loads of 25 tons or more, is a comparatively costly one, and unless it is reasonably well-filled, it has, by contrast with the normal wagon, an excessive, instead of a relatively low, dead weight. For this reason, it would manifestly not be a wise or profitable proceeding to construct high-capacity bogie wagons in large numbers without due regard to the necessities of the case. It has been thought —rather illogically—by some writers, that trade would follow the big wagon as a matter of course. It has not yet done so, however, in so far as the high-capacity vehicle proper is concerned, despite the numerous examples of the latter which are already running. It would be more correct to say that the really big wagon follows trade. Unfortunately, owing to the present commercial depression, there are decreasing, not increasing, opportunities to employ vehicles of high capacity efficiently. It might be contended that such vehicles, of from 30 tons upwards, should invariably be kept back until full, or, at least, adequate, loads are obtained for them, but this plan would have the effect, if carried out literally and indiscriminately, of diverting more traffic to the common roads than is at present the case. For the conveyance of general merchandise, the Railway Clearing House, some time ago, decided on a 12-ton open goods wagon as a standard one, and of this pattern many hundreds of examples have been turned out during the past few years. This wagon undoubtedly serves its purpose remarkably well, in a country like Great Britain, where the short haul and the small consignment are the rule rather than otherwise. So that it is but fair to assume that the railway companies would not continue to renew stock of this load-content if it could usefully and economically be replaced by much bigger vehicles.

Even for the carriage of coal the double-bogie wagon, although distinctly the right thing in special cases, does not come out altogether favourably as compared with the 20-ton four-wheeler. In a discussion on "Iron and Steel Railway Wagons," at the Institution of Civil Engineers in 1904, Mr. Oliver Bury, a former general manager of the old Great Northern Railway, gave a pertinent illustration of this fact. He showed that of four mineral trains, each having an identical freight of 420 tons and consisting respectively of forty-two 10-ton wagons, twenty-eight 15-ton wagons, twenty-one 20-tonners and fourteen 30-ton double-bogie vehicles, the last-mentioned train was neither the shortest in total length nor the lightest in gross weight. Of the foregoing examples, the train which showed to the best advantage was the one made up of 20-ton four-wheeled wagons. This train, according to the dimensions given by Mr. Bury, was 62ft. shorter and 4 tons lighter than the one comprised of 30-ton bogie vehicles, the percentage of the tare weight to the aggregate weight being 30 per cent. for both trains. Thus, apart from the correspondingly greater first cost of the bogie vehicles, there would be double the number of wheels, axles, and axle-boxes to keep in order, in comparison with the similar parts of the four-wheeled wagon trains. Although the disparity in length between such trains is not always, load for load, as great as that stated above, it appears that, in a general way, for equivalent paying loads, mineral trains consisting entirely of high-capacity bogie wagons would very likely exceed in length trains formed of 20-ton four-wheelers, but not, of course, those made up of either 15-ton or 10-ton wagons. It has become the custom of later years, it is true, to run very long coal and goods trains, but these are comprised of vehicles of various ages, weights, and sizes, and consequently cause heavy and erratic strains to be imposed on the older draw-gear, with the result that breakaways are more or less inevitable.

Thus, for ordinary coal traffic, the 20-ton wagon, as suggested by Sir Felix Pole, would still seem to be the ideal one. It obviously possesses special advantages of its own, and is one well suited to British traffic conditions. It can be constructed, it has been authoritatively stated, for about two-thirds of the cost of two 10-ton wagons. In contrast with vehicles of the double-bogie type, it is both cheaper to build and less costly to maintain. Where, however, exceptionally large consignments and those in bulk have to be conveyed, the high-capacity bogie wagon is unquestionably preferable, and its more extended adoption, if and when possible, is therefore not improbable.

But its indiscriminate multiplication is another matter, and British trading requirements being what they are, and differing as they do from those of other countries, especially in the number of small merchants and retailers, in closely connected towns, there is no opportunity at present for the complete abandonment of the four-wheeled wagon.

The elimination of privately owned vehicles, as such, would no doubt be a distinct advantage. According to recent statistics, there are 530,387 of these wagons, comprising 146,633 belonging to colliery proprietors, and 383,754 owned by private firms and merchants. This is the most troublesome part of the wagon question, and being chiefly one of finance, cannot be discussed herein.

THE second 80,000 kW turbo-generator at the Charles R. Huntley station of the Buffalo General Electric Company has been started up. It works with steam at a pressure of 435 lb. per square inch, superheated to 750 deg. Fah.

A New Australian Locomotive Works.

By C. P. JENKYNS.

THE reconstruction of the locomotive department of the Commonwealth Railway at Port Augusta, in South Australia, offers a number of points of interest to those connected with railways.

Port Augusta is Australia's solitary inland deep-sea port, and being almost geographically in the middle of the continent, should naturally become the ultimate centre of railway industry. At the present time, however, owing to the lack of capable direction and the natural effect of nearly a generation of socialistic misgovernment, it is merely a backwater, the stagnation of which is disturbed thrice weekly by the passage of the transcontinental train.

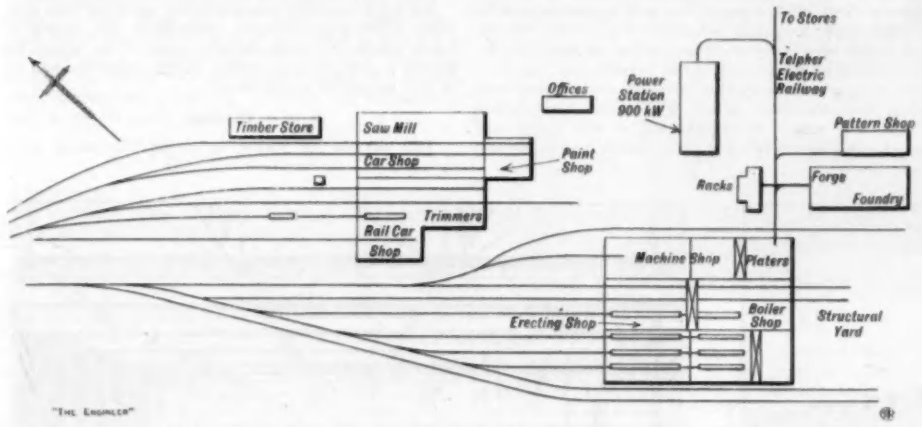


FIG. 1—LAY-OUT OF THE PORT AUGUSTA LOCOMOTIVE SHOPS

Temporary workshops were erected in 1917, and were supposed to meet the requirements of about forty locomotives and corresponding rolling stock, but they were inadequate before they were completed. At the time the writer arrived in December, 1928, to plan new works, the confusion due to the absorption of the South Australian Great Northern Railway and the normal growth of repair work and new construction, was simply indescribable. The shops consisted of a main timber structure with a number of lean-tos, and auxiliary shacks, the only cranes available being a 35-ton breakdown steam traveller and a 5-ton fixed radius shunting locomotive crane, which stopped all other operations immediately they entered the shops. The old power equipment was a miscellaneous collection of units, having no earthly relation to the job. It was housed in a wooden shack which gave no protection whatever, and which has cost the country many thousands of pounds in deterioration of the plant.

Construction of the permanent works and reorganisation of the existing works at Conwaytown was commenced in 1927 by filling a site of about 5 acres to an average depth of 3ft., and the Department now possesses a modern efficient plant, which under capable management will be able to effect very large reductions in the future maintenance costs.

THE NEW BUILDING.

The new building is entirely of steel—Fig. 2. The reinforced concrete foundations rest on 20ft. piles, of which there are 418. The building is 288ft. long by 213ft. 6in. wide, with a floor area of 62,000 square feet, and is divided into three bays of twelve 24ft. panels each. The centre and south-west bays are 75ft. 3in. wide and the north-east or machine shop bay is 61ft.

The total weight of materials used in construction exceeds 3000 tons, whilst over 15,000 tons of material, filling, ballast equipment, and machinery have had to be handled in the process. These figures convey some idea of the magnitude of the job.

Erection of the skeleton was expeditiously performed by means of two 100ft. steel derricks and steam winches, under the supervision of Mr. F. R. Morris, engineer for ways and works, and completed exactly to schedule, without a single accident of any consequence to a workman—certainly a record to be envied. One of the derricks appears in Fig. 2. It is very sad to have to recall, however, that Mr. Morris himself met with a serious accident later, which prevented him from completing the building, his absence resulting in much vexatious delay and disorganisation, as it can be readily understood that capable engineers are few and far between in these outback places.

Over 66,000 bolts with their respective nuts and washers were used in assembling the structure, the total weight of which is over 800 tons.

The roof is of saw-tooth formation, as is customary in hot countries. It has steel-framed windows for the full area of its south-eastern aspect, shown in Fig. 4, glazed with ¼in. wired glass for safety in the event of breakage, as the fall is over 40ft. Side lights on three sides, glazed with non-actinic glass, permit further illumination without the transmission of heat or glare, a very necessary consideration with a shade temperature of 121 deg. Fah. There are 30,600 square feet of glass in the building.

Artificial illumination, designed by the writer, is effected by 500 and 1000-watt gas-filled bulbs in Benjamin R.L.M. 486 reflectors, giving a uniform illumination, without shadow, of about 6 foot-candles at the working plane, thus entirely obviating local lighting, with its concurrent dangers and disadvantages.

The points are grouped into circuits, so that each department can be lit independently, and all switches are mounted on a three-panel distribution board erected on a steel gallery above the main door in the centre of the shop on the north-east wall. One circuit is controlled from floor level by two change-over switches, one at either side door, with the points so arranged that every gangway is sufficiently illuminated for the night watchman's inspection and safety, and so that he may enter and leave by either door at will.

The distribution board is fed through a 600-ampère contactor isolator, double-pole, remote-control, operated by a push-button station at the north-east main door. This control is interlocked with the switchboard gate, so that when the latter is opened it automatically isolates the board and shop. The board cannot be energised again until the gate is shut, locked, and the key returned to its receptacle, which completes the contactor circuit.

There are twenty D.B. major ironclad switches and fuses for control of the lighting, 220-volt plug circuits, and ten 100-ampère and one 150-ampère B.T.H. hand-operated circuit breakers, with overload and low-voltage releases, which are the master switches for all the overhead crane and power circuits.

The under-volt protection was incorporated to ensure the automatic clearing of the board in the event of a power failure or the opening of the isolator, but a time lag prevents undue operation of this element. These switches also are fully ironclad and have visual signals by means of which, owing to the elevated and central position of the board, much time will be saved, and faults detected and made good with the minimum of delay. Power comes in from the generators over twin cables to ensure continuity of supply.

The first two panels of the north-east bay contain the wheel shop, in which a modern heavy-duty wheel lathe, an oil-fired tire table, hydraulic wheel press electrically driven, and self-contained electrically driven axle lathe, all served by a 10-ton overhead electric crane, will deal expeditiously with all the wheels required by the department.

The next seven panels contain the machine shop, whilst the last three are devoted to the platers, and boilermakers' machine shops. The nine northern panels of the centre and south-west bays are the fitting and erecting shops, whilst the last three are occupied by the boilers under repair. There is room for twelve boilers at one time in this section.

Table I. shows the relative areas of the old and new works, and clearly indicates the inadequate accommodation of the plant prior to reconstruction.

TABLE I.

Department.	Old shops. Square feet.	New shops. Square feet.
Boiler shops	8,184	15,356
Fitting and erecting shops	9,240	42,976
Machine shop	5,355	13,176
Car and paint shops	18,672	36,000

Seven 16ft. doors on the north-west front give access to the yard tracks for locomotives and cars, and there are four similar doors at the south-east leading to the structural yard, behind the boiler shop, where underframe and other structural-steel work is performed under a Hannah pneumatic riveter. This arrangement is possible because rain is practically unknown, and the shadow of the building gives a fair amount of protection from the sun.

In addition to the two 9ft. doors in the north-east and south-west sides, already referred to, connected by a mixed gauge transfer track right across the shop, there is a 17ft. door in the north-east wall at the eleventh panel, giving access to the yard telpher railway, which is, of course, above the loading gauge height limit.

The concrete floor is reinforced with B.R.C. fabric No. 655, and is 4½in. thick. It is sufficiently strong to carry most of the machine tools, including a heavy planer, without any other foundations, thus saving greatly in erecting costs and facilitating subsequent removal to meet altered conditions. A 1½in. mastic asphalt cover is laid on the floor, providing an ideal workshop surface, comfortable for the workman, free from dust, waterproof, and harmless to fine work dropped on it. This material must be kept free from oil, and weights left upon it mark it. These slight defects notwithstanding, it is, in the writer's opinion, far superior to any other form of flooring for an engineering works. Traffic soon obliterates any marking, and excavations and repairs can be made with the maximum expedition and at the minimum cost.

All machines, motors, control panels, &c., were placed in position, levelled and grouted in on the concrete, the mastic asphalt being then finished right up to and around them, with any conduits or other pipe connections buried therein. In no case were any

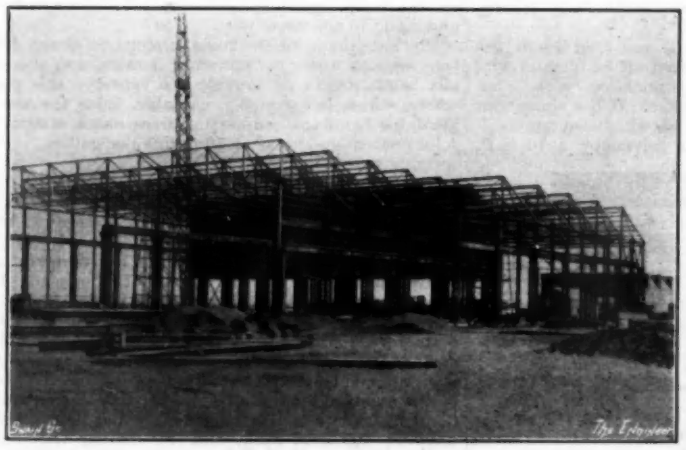


FIG. 2—ERECTION OF THE NEW BUILDING

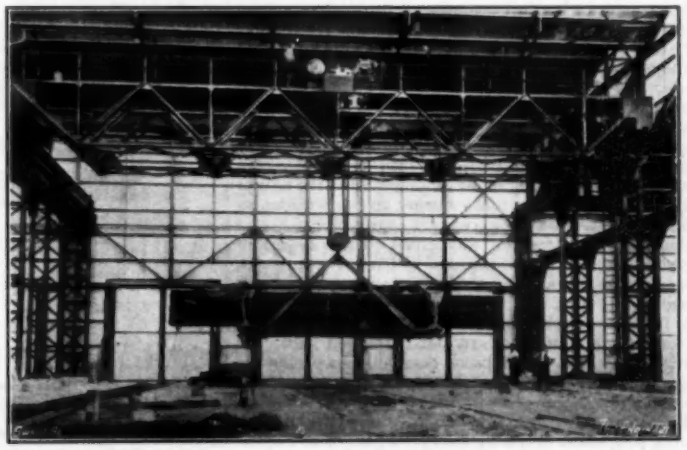


FIG. 3—60-TON CRANE UNDER TEST

bolts or other fastenings whatever required, saving hundreds of pounds in installation charges, and permitting machines to be moved as required at very small cost.

Electric cables, air mains, &c., are laid in 8in. square troughs cast in the concrete floor—shown in section in Fig. 6. The sides and base of these troughs are coated with a thin layer of bitumen for protection against moisture and cracking. Cable conduits are laid on this floor and covered by a layer of washed and dried sand, which is then sealed down by a further layer of bitumen, about ¼in. thick. Air, water, and other mains, if in the same trough, are laid on top of the sealing and are open, except for the 2in. timber cover and the 1¼in. mastic asphalt floor. Thus all lines are fully protected, but easily accessible. A plan of the shop shows the exact location of all these troughs and, in addition, at each corner or junction a 1in. diameter copper disc is set into the asphalt floor to indicate the position of the troughs beneath. Every conduit fitting has an inspection cover: hence it is only necessary to open up a very small section of the trough at a time for testing or repairs.

In the walls of the engine pits, recesses, in which a pneumatic and an earthed electric connection are fitted, are provided at frequent intervals. This arrangement gives convenient supplies of either form of power for portable tools and lamps, ensures complete protection to the valves and plugs, convenience for the workmen, especially under narrow-gauge engines, and prevents cables and hose obstructing the floor and becoming damaged.

The electric conduits are buried in the walls of the pits, but the pneumatic mains are carried in channels on the face to facilitate the detection and repair of leaks, whilst giving full mechanical protection.

Pneumatic connections to hoses are made throughout the plant by means of Westinghouse valve couplers, thus eliminating cocks and innumerable joints, thereby considerably reducing maintenance costs. With this form of coupling, two little valves, which normally close the orifices, are held open, when the coupling is joined and immediately close upon breaking the joint. No skill is required to operate, and the saving in air alone pays for the equipment in a very short while. Owing to there being no threads, the maintenance costs are negligible.

Considerable attention was given to the design of the pits to secure the maximum width between walls, especially in the narrow-gauge pits, where the track gauge is 3ft. 6in., and actual distance between walls 3ft. 1in. As a matter of fact, by using special rail plates, in place of standard flat-bottomed rails, the full gauge width could have been obtained, but as large stocks of F.B. rails were held, the writer was forced to use them.

There are two narrow-gauge pits, two mixed, having four rails, and four standard-gauge, 4ft. 8½in., providing accommodation for twelve locomotives at a time.

All lifting and transportation of material is accomplished by one 10-ton and two 60/10-tons overhead electric travelling cranes, made by Herbert Morris, of Loughborough, which cover practically the whole of the floor area. The transfer track, already referred to, gives a ready means of transferring loads from one bay to another, and the overhead electric telpher gives direct connection between the shops, foundry, forge, and stores, reducing handling charges to a minimum, and assuring expedition and safety.

The boiler erecting shop floor consists of a heavy ash filling on sand, permitting cheap excavation when necessary, but, in the writer's opinion, this is only a supposed advantage, and hard wood blocks laid on concrete are a much safer and cheaper proposition, even allowing for extra packing and scaffolding around boilers.

Two portable D.C. electric arc welding plants and a portable electric radial drilling machine are in use in this shop. They are supplied by means of trailing armoured cables, through Dorman and Smith's interlocked plug switches, mounted at convenient points throughout the shops. All these machines are earthed through the armouring of the trailing cable.

Electric and pneumatic mains in this shop are carried overhead, numerous connection points being provided on the shop columns at working levels, and great care has been taken to earth and interlock all electrical apparatus, so that the possibility of accident is extremely remote. This, of course, applies throughout the plant.

Offices and Tool Room.

Offices for the foremen are constructed entirely of steel with double glass panels for walls, so that a continuous view of the whole of the shop floor is obtained by the occupant. They are carried on beams immediately beneath the overhead crane girders, and are 20ft. above the shop floor level, access being given by means of all-steel stairs. This construction ensures a silent office, a point that will appeal especially to boiler shop foremen, effective visual supervision of the shop, and efficient illumination day and night.

A thermo-syphon system of ventilation is provided, taking air from the base of one of the supporting columns by a trunk, which after circulating through the office is discharged at the shop roof summit. As there is over 50ft. difference in level a good supply of pure air is assured with equable temperatures throughout the year.

No artificial lighting is required as the shop system is sufficient, the walls being transparent.

The floor is constructed of Decalite, selected for its strength, and insulating properties, the latter being extremely important in a country where temperature ranges from 30 deg. to 121 deg. Fah. in the shade, to say nothing of the writer's office thermometer having reached 132 deg. Fah. on one particularly thirsty day in January.

Rough stores, finished stores and tool room are all areas of the main floor, fenced off with chain wire fencing, carried on T-iron stanchions with convenient doors and serving hatches. It has since been found necessary to roof them in with wire panels.

The tool room line shaft is driven by a 10 H.P. motor held in position on the floor entirely by its own weight and the bitumastic asphalt. All machine cutting tools are kept in duplicate, and are ground and repaired in the tool room, to ensure the most efficient type being in use, saving greatly in time, abrasion, and tool steel, with increased output.

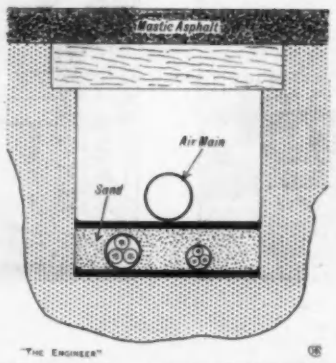


FIG. 6—SECTION OF FLOOR TROUGH

Electric pedestal grinders are installed in the erecting shops only. These are American, no British machines having been offered, despite the fact that every effort was made to secure tenders of British makes. Instances of this can be quoted *ad nauseum* by engineers in these overseas countries.

The two line shafts are carried on the main shop columns about 2ft. above the floor level, and run in Skefko bearings. The motors of 30 H.P. each and all countershafts are mounted on two channel iron stringers, running the whole length of the shop, about 9ft. from the floor. This is the writer's favourite method of running line shafts, because the whole of the apparatus is easily got at and kept clean, repairs and alterations are easily effected at a convenient height, the load on the main bearings is greatly reduced, the components acting in opposition, and the motors are out of the way, yet accessible, and do not occupy valuable floor space. It was first installed by him in Australia, in the Islington shops of the South Australian Railways.

All lathes and hollow spindle machines are set at an angle of about 25 deg. to the line shaft, the angle drive being made between the line and countershafts. In this connection it is surprising how many otherwise capable engineers will assure one that the thing cannot be done, and predict disaster for the system. With a little care, however, even a double belt reversing drive can be mounted in a perfectly satisfactory manner in this way.

All the remaining machines are motor driven direct, with individual motors controlled by Australian-made automatic push-button controllers, which have shown a considerable saving in the maintenance costs of the electrical equipment.

Water.

The supply of water is about the most serious problem on this railway, and much thought and ingenuity is always being expended on it. The main industrial supply to the workshops comes from Depôt Creek into a 10,000-gallon tank on a 40ft. stand alongside the works to ensure a good head and steady supply.

In the boiler shop a sump is provided to receive all testing water, which is pumped back to a service tank by an automatically controlled electrically driven pump, operated by the varying levels in tank and sump in the usual way.

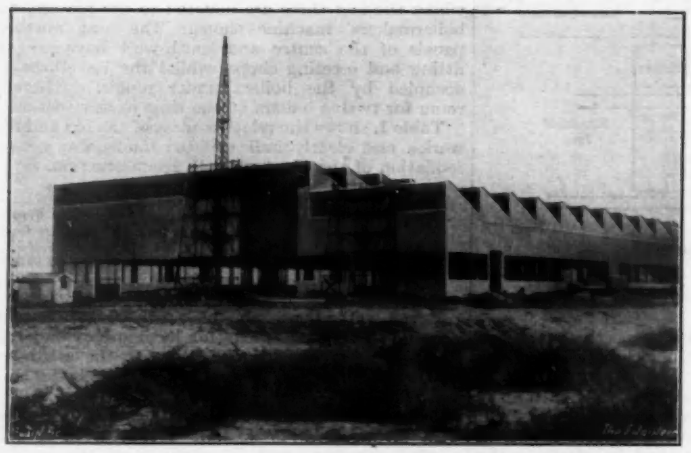
The catchment of the roofs is equal to about 2000 tons of fresh water per annum if it rains, and eventually tanks are to be provided to conserve this pure water, which is extremely valuable, since the water available from the ordinary sources has a minimum solid content in excess of 50 grains per gallon.

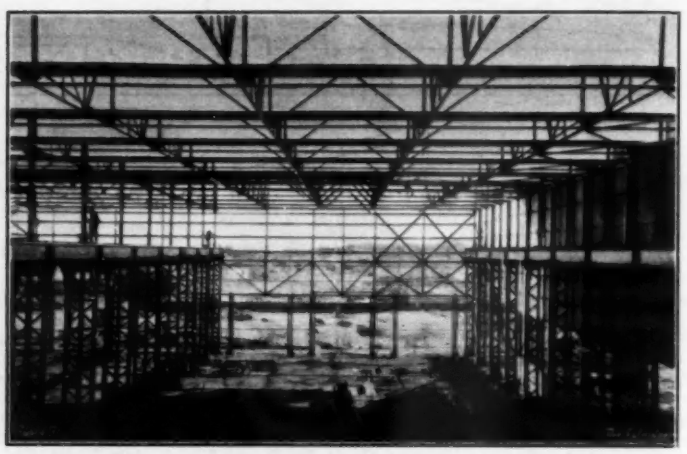
The Foundry.

The core oven, designed by the writer, offers a suggestion for utilising cheap current at night to any foundry in an area where it is obtainable. It is operated by four General Electric low-temperature industrial heaters, having a load of about 16 kW. The oven is 10ft. by 6ft. by 7ft., and is constructed of hollow concrete blocks with an inner lining of terra-cotta bricks with 3in. air space between. Air enters at floor level by ducts, passes up through the heating elements and leaves by a vent at floor level at the back of the oven and a chimney fitted with a regulating damper. Six to eight changes of air per hour can be used at 400 deg. Fah., and by setting the time switch for, say, two or three hours' working at midnight or whenever the cheap tariff becomes available, the cores will be found to be all ready and in perfect condition for next day's work.

A two-hole forced draught Horne type furnace, each hole having a melting capacity of 450 lb. of brass or 200 lb. of iron per hour, with a 5-cwt. and a 15-cwt. Thwaite's cupolas, the latter fitted with "Crawford's" receiver by the writer, constitute the melting shop equipment. This receiver is directly beneath the cupola, and is much more efficient than the separate type of receiver, but requires slightly more skill in handling.

The sand is divided into four beds, two for iron and two for brass, and to ensure its purity and freedom from creeping salts, concrete walls are built round each bed and Malthoid, sealed with bitumen, laid on the bottom. This also conserves moisture in a locality where water disappears at an alarming rate. The addition of a moulding machine brings the capacity of the foundry up to about 2000 tons of mixed castings per annum, as against 400 tons under the old conditions, with no increase in labour or floor area. An overhead crane covers the iron beds, and all beds





FIGS. 4 AND 5—EXTERNAL AND INTERNAL VIEWS OF THE NEW BUILDING NEARING COMPLETION

are fitted with slide rails, enabling all box moulding to be done away from the melting shop, and keeping all pouring together.

All power for the foundry and smithy is electric, and is controlled by a distribution board as in the main shop. The hammers are motor-driven Massey pneumatics, and the air supply for seven forges, the cupolas, brass furnaces and copper shop fires, is taken from one 15in. Davidson Sirocco, driven by a 20 H.P. motor at 4000 r.p.m. Large shutters are arranged in the wall opposite each smith, which he can open in the hot weather to admit air without sunlight.

The old tube rumbler, which revolved in the open air, creating a most abominable din and dust, was arranged to sink down into a pit full of water and to rise on the completion of the rumbling operation, discharging on to a pair of movable rails, and so through a trap door into the shop for cutting and re-ending on machines designed and built at the works for the purpose. They comprise a tube bell-mouthing machine, in which the complete operation occupies about 20 sec., and a brazing machine, the capacity of which is about sixty joints per hour.

The New Power Station.

A new power station is being built in close proximity to the works, as shown in Fig. 1. It will be equipped with solid injection, four-stroke, oil engines, built by W. H. Allen, Sons and Co., Ltd., of Bedford, and D.C. generators by the same firm. The switchboard is of Australian manufacture. There are two units of 308 H.P., 200-kW output and one unit of 740 H.P., 500-kW output at 440 volts reticulated by a three-wire system with earthed neutral. The opportunity was not taken to secure the advantages of changing over to A.C. operation.

A 250 H.P., 1200 cubic feet vertical, direct motor-driven air compressor, by Kelly and Lewis, of Melbourne, will supply air at 100 lb. per square inch to the plant, *viâ* a 500 cubic feet receiver and 4in. overhead mains. This machine is controlled by full automatic switchgear and pneumatic loading device giving great running economy and light unloaded running.

The station auxiliaries include a separate petrol-driven starting bottle charging compressor, static balancing transformers, salt water fire pumps, and air conditioning plant. The latter cleans the whole of the air entering the station for every purpose, including ventilation, and supplies it at a slight positive pressure to ensure a perfectly dust-free building, dust being the second greatest problem, after water, connected with the successful running of oil engines and compressors. The plant will also regulate the humidity and temperature of the engine-room, which in that climate is liable to become as unbearable as a tramp stokehold in the Red Sea with a following wind.

Circulating water for the power-house is to be obtained from a deep sea water wharf, approximately 1 mile distant, by means of duplicate, drowned, vertical-spindle centrifugal pumps, driven by electric motors, controlled by automatic switchgear operated by push buttons on the power-house switch gallery. A rising main and tank at the power-house provides storage accommodation in the event of both pumps being out of commission, and for starting up from a complete shut down. The discharge from the station is led straight out on to the beach about 1½ miles from the intake, so that there is no possibility of hot water re-entering the system.

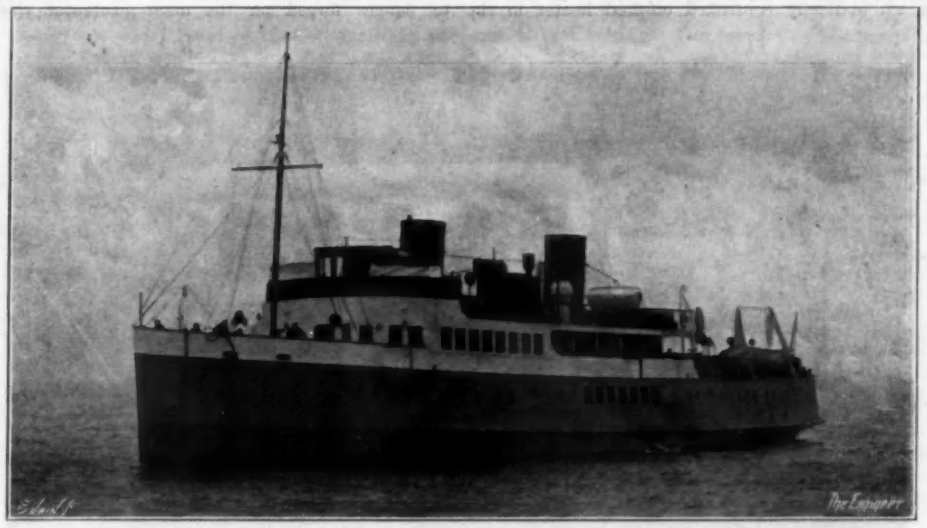
The site of the power-house is on extremely bad ground, but there was no alternative, owing to the employment of D.C., and it will be interesting to civil engineers to watch the behaviour of this station when in operation. To facilitate repairs a 10-ton overhead travelling crane is provided. It runs the full length of the station controlled by automatic switchgear operated from the floor level under "dead man control," so that if the operator lets go, all motions immediately cease.

To secure air-tightness, general ingress and egress is by a revolving door, fitted with an electric release, so that no one can enter or leave except with the knowledge of the switchboard attendant. An air-tight steel roller blind, operated by a motor, closes the aperture through which the machinery enters the building, and one emergency door normally kept locked is provided. Balanced louvres in the roof permit escape of air from the building, but prevent the entrance of outside air and dirt.

The total cost of the works described in this article is approximately £155,000, and it is expected that a saving of over £10,000 per annum will be effected to warrant the expenditure.

ELECTRICALLY-PROPELLED MOTOR SHIP LOCHFYNE

WILLIAM DENNY AND BROTHERS, DUMBARTON, BUILDERS



The Electrically-Propelled Motor Ship Lochfyne.

BUILT to the order of David MacBrayne (1928), Ltd., by William Denny and Brothers, of Dumbarton, the motor ship "Lochfyne" marks a new development in the application of electrical machinery to ship propulsion, for this is the first shallow-draught high-class passenger vessel engaged in coastal service to be equipped with this form of propelling machinery. The oil-electric system of propulsion that has been adopted enables all the domestic requirements of the vessel to be met by the main engines, and, needless to say, the advantages of the supply of electrical energy have been fully exploited with a view to promoting the passengers' comfort and obtaining economical operation. The principal dimensions of the vessel, which is capable of carrying about 1200 passengers, are —length, 215ft.; breadth, 30ft.; depth to main deck, 10ft. 3in.; and load draught, 7ft. 6in.

The arrangement of the ship has been devised to suit a one-class summer service on excursion runs from Oban, and the normal two-class service on passenger and mail runs on the Clyde from Greenock to Ardrishaig. As catering facilities are of special importance on the Oban service, a large dining saloon has been provided on the main deck forward and a tea room aft, an arrangement which has led to an innovation as regards Clyde service —namely, the carriage of saloon passengers forward

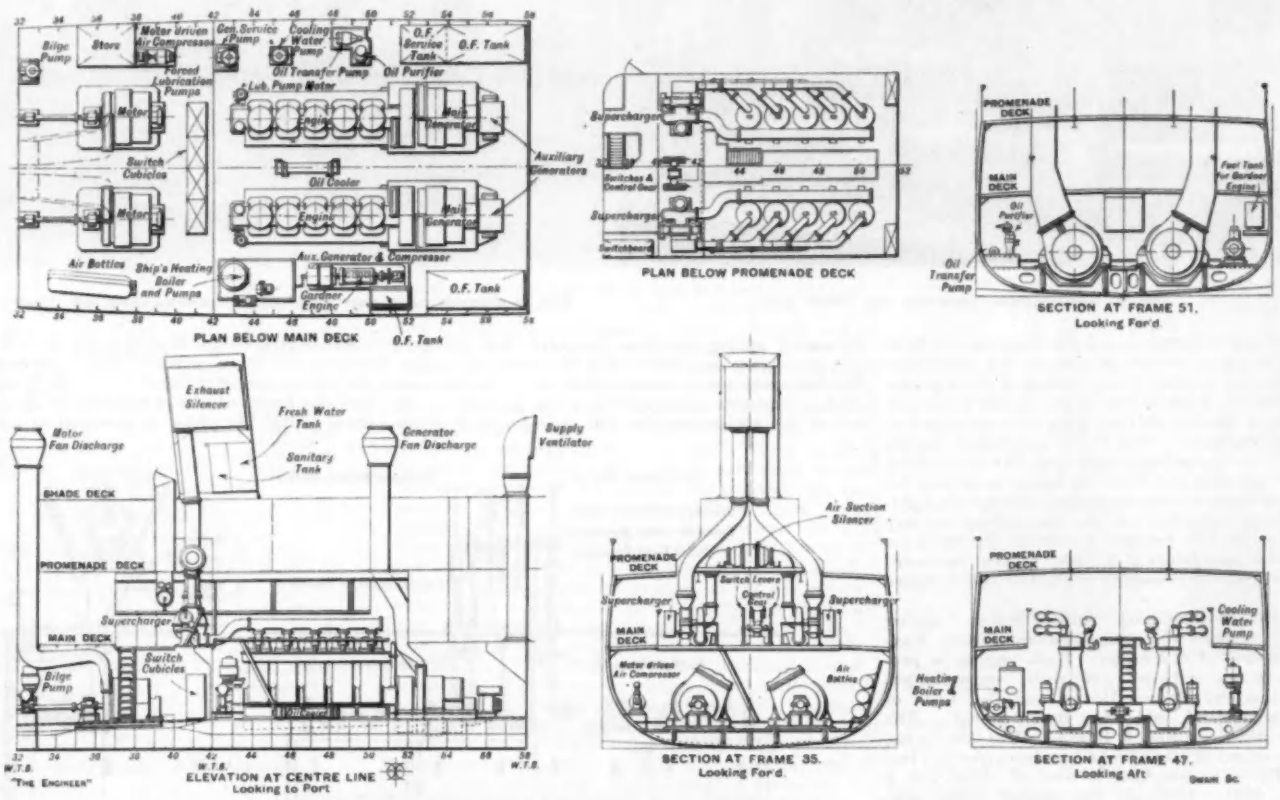


FIG. 1—ARRANGEMENT OF THE PROPELLING MACHINERY OF THE LOCHFYNE

and steerage passengers aft. The whole accommodation is very pleasing in design and execution. All the cooking is done electrically, and in addition to regular *table d'hôte* meals, the inclinations and tastes of passengers can be met at any time of day. The ship is heated throughout by a hot-water system from an automatically controlled oil-fired heater in the engine-room, whilst hot and cold water is supplied to the lavatories from calorifiers provided with thermostatic control, the heating system being kept quite independent of the hot fresh water service, so that the radiators can be shut down during the summer months.

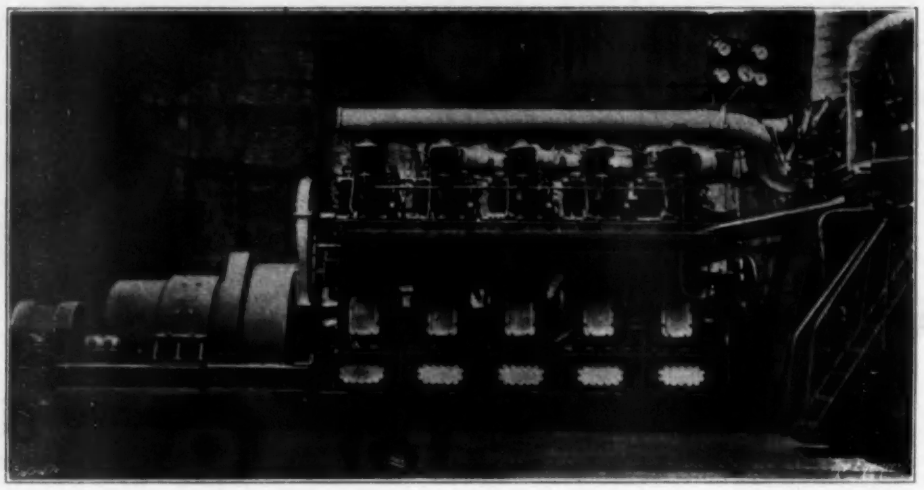


FIG. 2—STARBOARD ENGINE AND GENERATOR ON TEST BED

THE OIL ENGINES.

The propelling machinery—see Fig. 1—comprises two electric motors, each coupled to a propeller through a line of shafting, and receiving current from two C.I. oil engine driven generators, the generators and propelling motors being arranged in separate compartments. Each of the main engines is directly coupled to a tandem set consisting of a main and an auxiliary generator. The main generators supply current to the propelling motors, while the auxiliary generators provide the electrical energy necessary for driving the engine-room auxiliaries and for the lighting, cooking, and other services throughout the ship as well as the field excitation current for the main motors and generators. A view of the starboard engine and generator erected on the test bed is shown in Fig. 2.

The two five-cylinder trunk piston "spring injection" engines were supplied by Davey, Paxman and Co., of Colchester. Each engine is provided with an exhaust gas-driven supercharger, manufactured by Brown, Boveri and Co., Ltd., of Baden, Switzerland, under the Buchi patents. The normal continuous rating is 1000 I.H.P. at 330 r.p.m., but an overload of 10 per cent. can be carried for two hours. The cylinders have a bore of 15¾in. and a stroke of 20in. Although the general design conforms with the standard Paxman practice, several modifications have been introduced to adapt the engines to marine service. The bed-plates, for instance, are of a particularly substantial design, and are constructed with a double box section along either side. These sections serve as reservoirs for the lubricating oil, whilst the main bed acts as a dry sump which is continuously scavenged by means of an auxiliary pump.

The crank shafts are forged in one piece with balance weights on each throw, the arrangement being such that there are no resultant horizontal or vertical free forces. The small rotating couple is only about one-third the magnitude of the couple on a three-cylinder engine of corresponding cylinder size, with the result that extremely steady running is secured. In the design of the engines careful attention was paid to the question of torsional oscillations, and there is no critical speed or harmonic within 20 per cent. of the running speed. The engines are directly coupled to flanges forged on the main generator shafts, which are extended through single outboard bearings to carry the auxiliary generator armature. At the fly-wheel end, the cam shafts are driven by totally enclosed, forced lubricated, Renold's chains, provided with adjustable jockey sprockets, whereby immediate adjustment may be obtained. Provision is also made for counter adjustment of the timing in conjunction with chain adjustment.

Injection of the fuel is carried out on the standard Paxman "spring injection" system, the plungers, jets, &c., being modified to suit the increased output. The fuel-measuring pumps, which are of the constant stroke, excentric-operated type, are carried on the end of the engines on the first cylinder, and driven by skew gears from the cam shaft. The amount of fuel delivered to the injectors is regulated by governors which control spill valves on the delivery side of each fuel pump. Small gear type fuel oil transfer pumps are fitted to the ends of the fuel pump excentric shafts, and draw fuel from the main service tank and deliver to the supply tanks situated adjacent to the engines. The governors are of Paxman's standard, totally enclosed, forced lubricated type, and are driven from the crank shaft. Hand control wheels are provided for operation, either from the engine-room floor or, alternatively, from the main control station between the two engines at about the height of the cam shaft. Independent of the governor control there are also hand throttles, operated from both stations, which act directly upon the fuel pump plungers and vary their stroke. It is thus possible to regulate the engine to any desired speed and at that speed the governors take control. The engines are said to be extremely flexible, and will turn over indefinitely at very low speeds.

The exhaust valve gear is of the makers' patented excentric type which is silent in operation and gives a rapid opening to the valves, thereby facilitating the requisite scavenge effect for the loads carried. The cam shafts are supported in gun-metal bearings from the engine cylinders and the operating gear runs in oil trays. With the exception of the air valves, the remainder of the gear is operated by excentrics, resulting in quiet operation. The lubricating oil pumps, are driven by means of independent electric motors, and the pumps on either engine are of ample capacity to serve both engines. Under normal conditions only one pair of pumps is used, but the motors are connected with automatic gear so that, in the event of loss of oil pressure the second set starts up automatically. The oil is circulated through large Serck oil coolers provided with cupro-nickel tubes. In addition to supplying the engines, the main pressure system also supplies oil to the supercharger and generator bearings. Independent mechanical lubricators supply oil to the cylinders, exhaust valve excentrics, and to the air and exhaust valve stems, which, on account of the induction and exhaust pressures being higher then atmospheric pressure, are fitted with piston rings running in special guides. Lubrication of all small details is provided by Menno greasers. The cylinders are cooled by sea water by means of separately driven circulating pumps. In accordance with usual practice, the engines are started with compressed air, which is admitted to all cylinders from a master valve. The arrangement of the main air and exhaust manifolds is such that the cylinder heads can be dismantled without disturbing those parts. In order to preserve as much heat as possible in the gases passing to the turbine, the exhaust pipes are lagged and the air inlet manifold is also lagged to prevent transmission of sound from the turbine. The exhaust is led to two branches, that from cylinders 2 and 5 going to one branch and

FIG. 3—PROPULSION MOTORS ON TEST BED

FIG. 4—PROPULSION AND AUXILIARY GENERATORS ON TEST BED

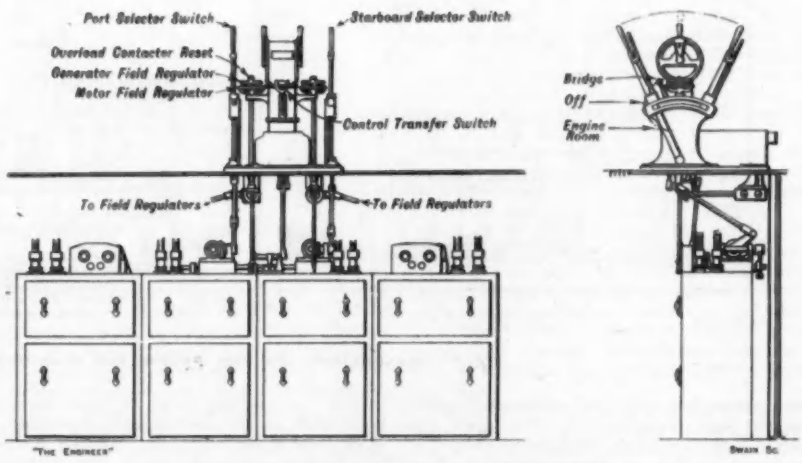


FIG. 5—ENGINE-ROOM CONTROL STATION

that from cylinders 1, 3, and 4 to the other branch. The main gauge boards are mounted above the main air trunks, and secondary gauge boards are provided for the Siemens exhaust pyrometers. The exhaust gas turbines are single-stage machines, directly coupled to single-stage turbo-blowers with a capacity of 2530 cubic feet of free air per minute. The normal speed of the superchargers is about 8600 r.p.m., with a maximum of 11,000 r.p.m., but actually speeds of over 13,000 r.p.m. were obtained on test.

Power from the main propulsion generators is supplied through the switch and control gear to the

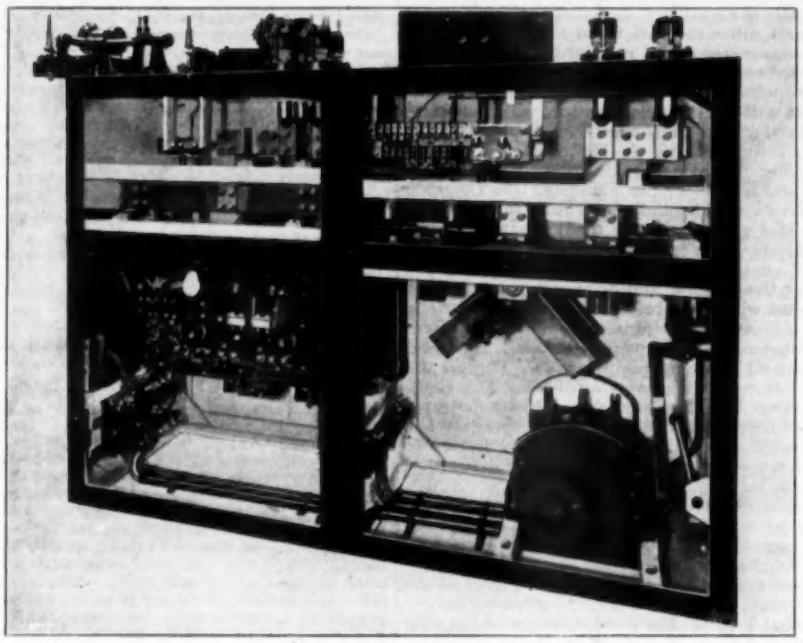


FIG. 6—SWITCH CUBICLE WITH COVERS REMOVED

two propulsion motors, and provision is made for running each propulsion motor from its own generator or, alternatively, the two motors can be supplied with current from either generator alone, so that the plant may be run at maximum efficiency both at full and at cruising speeds. The main propulsion motors may be controlled from the bridge or alternatively from the engine-room, by means of a telegraph or speaking tube communication with the bridge. The two auxiliary service generators driven in tandem with the main propulsion generators feed the ship's auxiliary system through an auxiliary

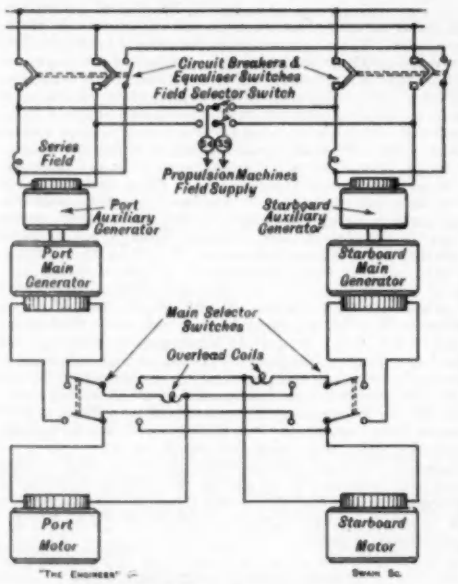


FIG. 7—ELECTRICAL CONNECTIONS

switchboard, and to allow for the regular operating condition with only one of the main operating sets in commission and to provide the skeleton service necessary in port there is a smaller oil engine generator. The output of this generator is also supplied to the auxiliary switchboard and the machine may run in parallel with either of the auxiliary generators driven by the main engines.

THE GENERATORS AND MOTORS.

All the electrical propulsion machinery and its control gear was supplied by the Metrolitan-Vickers Electrical Company, of Trafford Park, Manchester, which acted as sub-contractor to the main contractors, Davey, Paxman and Co., Ltd. Each of the main motors—see Fig. 3—is rated at 670 B.H.P. at 438 r.p.m., with a substantial margin for overloads, whilst the propulsion generators—see Fig. 4—are rated at 540 kW at 520 volts when running at a speed of 330 r.p.m., and have, of course, a similar overload capacity. To allow for variations in weather and hull conditions the motors are designed to give their rated output over a speed range of plus or minus 10 per cent., and this variation does not involve any variation in the speed of the engines, which can therefore give their full output over the entire range of propeller speed adjustment, a feature which gives the electric system an advantage over the direct-coupled oil engine system in which any reduction of propeller revolutions to meet increased resistance involves a corresponding reduction in the available output of the engines. At the maker's works the propulsion motors were tested by coupling them together as shown in Fig. 3, and an elaborate series of measurements of efficiency was made to provide the basis for investigation into the performance of the vessel. The motors are shunt wound, open type, fan ventilated machines and are excited from the ship's auxiliary circuit through a protected circuit. The air, heated in its passage through the machines, is exhausted through trunking in the shade deck, and special precautions are taken to prevent the ingress of moisture to the trunking and machines. The forward bearing is of the disc lubricated sleeve journal type, as adopted by the Metropolitan-Vickers Electrical Company for all ship propulsion motors. The after bearing is a combined thrust and journal bearing, and carries approximately half the weight of the rotating part of the motor. The journal bearing, which is of the sleeve pattern, is divided into two sections to admit the collar and pads of a Michell thrust bearing, and the collar acts simultaneously as a lubricating disc. These combined thrust and journal bearings were supplied by the Mitchell Bearing Company.

The propulsion generators and direct-coupled auxiliary generators—see Fig. 4—are shunt-wound machines, and, like the motors, are excited from the auxiliary system. To ensure stiffness there is no bearing between the generator and engine. At the remote end the bearing is forced lubricated with oil from the engine lubricating system. Each of the two auxiliary generators is rated at 48 kW at 230 volts and is capable of an overload capacity of 25 per cent. for two hours. As will be gathered from Fig. 4, showing the main and auxiliary generators on test, the armature of each of the latter machines is overhung from a coupling on the main generator shaft, whilst the yoke is carried on a bracket on the main generator bed-plate. Like the main generators, the auxiliary machines are ventilated by a fan mounted on the armature, but owing to the small amount of heat generated it was not considered necessary to carry the exhaust air out of the engine-room.

The engine-room control station—see Fig. 5—is at the main deck level, and in a position overlooking the engine and motor room. Briefly, this control station comprises a manœuvring controller for the port and starboard propellers, a switch lever for the transfer of control between the bridge and engine-room, port and starboard selector switch levers for grouping the motors, and generators for service with one or two engines, hand wheels for the fine adjustment of propeller speed and engine loading, and reset knobs for the overload protective contactors. All the instruments used for logging the performance of the plant, including indicators for giving the speed of the propellers, are grouped together on a single instrument board. At the control station there is also the engine starting and speed regulating gear, whilst the auxiliary switchboard is nearby. The switches operated from the control station are contained in an enclosed steel cubicle mounted immediately below the control station, as shown in Fig. 5, which also shows the arrangement of links and gearing between the control station and cubicle. The interior of the starboard side of the cubicle with the covers removed is shown in Fig. 6. With the exception that the port side of the cubicle contains the bridge to engine-room control transfer switch, it is similar to the starboard side.

MANŒUVRING.

The regulators for the fine adjustment of speed and load are mounted on the bulkhead on either side of

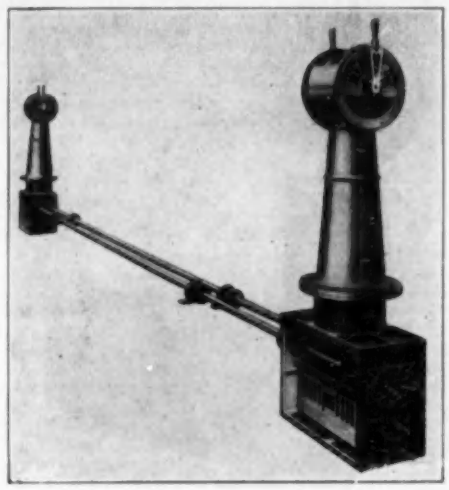


FIG. 8—BRIDGE CONTROLLERS

the cubicle, and are driven through bevel gearing and shafting. The simplicity of the system will be apparent from Fig. 5. Once the plant has been arranged by the appropriate setting of the three levers, and the engines have been started before the time of departure, the engineer has merely to operate the controller and the four hand wheels when changes of speed are required. The simple nature of the main connections that have to be established can be seen from Fig. 7. If, as will normally be the case, bridge control is to be used, the control transfer switch is set in the appropriate position and the engineer then simply deals with the fine control of speeds and loads. The bridge controllers assembled in the maker's works are shown in Fig. 8. On the vessel the lower part of the controllers containing the speed selector switches

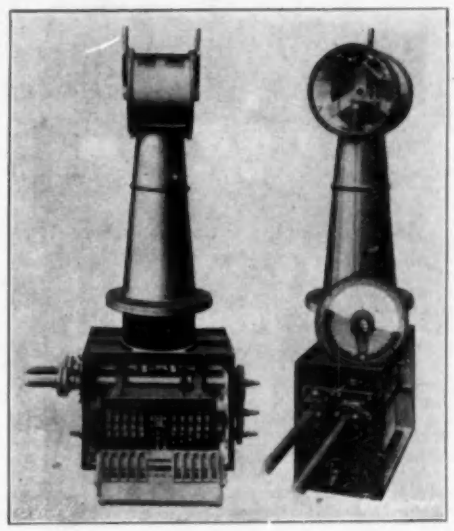


FIG. 9—CONTROLLERS SHOWING CONTACTORS

is mounted below the bridge. The shafts coupling the controllers at each side of the bridge are, of course, also below the bridge. Each controller has two handles, one for the port, and the other for the starboard motor, the corresponding handles on the two controllers being coupled together so that the port or starboard controller may be used according to which is most convenient. The movement of the controller handles is transmitted through gearing to cam-operated speed selector contactors arranged in the base of the controllers, as shown in Fig. 9. There are two groups of ten contactors, one group for the port, and the other for the starboard machinery, and each group is mounted in the base of one controller. Of the ten contactors in a group, four in pairs, determine the direction of rotation of the corresponding motor, and the remaining six give

speed steps corresponding to one-quarter, three-eighths, one-half, three-eighths, and seven-eighths full speed, intermediate speeds being obtained by regulator control in the engine-room. The interior of the head of a controller with the side plate removed and reversed to show the notched plate to indicate to the operator the various speed notches, is illustrated in Fig. 9.

In addition to this device, each controller is fitted with two electric speed indicators, so that the operator may know the actual propeller speed. The interior of the controller head is illuminated by electric lamps, which only light up, however, when the bridge control gear is in use, and they therefore serve as a safe-

FIG. 10—ENGINE-ROOM CONTROLLER

guard against mistakes. When engine-room control is employed communication between the bridge and engine-room is established by the conventional telegraph which has additional signals corresponding to the system of control in use. The engine-room controller operates on the same principle as that of the bridge controllers, the two groups of contactors being mounted in the base of the single controller, which is shown in Fig. 10. Electric controllers as used on this electrically propelled vessel require no more attention on the part of the operator than that needed by the conventional telegraphs, and bridge control of the kind under consideration removes all possibility of misunderstanding and at

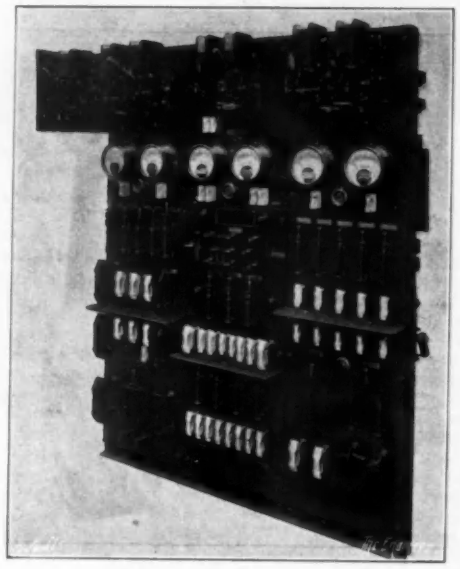


FIG. 11—AUXILIARY SWITCHBOARD

the same time eliminates delay in carrying out manœuvres.

AUXILIARY MACHINERY.

The auxiliary switchboard shown in Fig. 11 was made by the Metropolitan-Vickers Electrical Company, and is designed to control the two 48-kilowatt generators, the standby generator, and the feeders to the various parts of the vessel. It consists of ebony sindanyo panels, which carry a double-pole circuit breaker for each generator, and single-pole knife switches with double-pole fuses for each feeder. On this switchboard provisions are made for the maintenance of supply for the essential requirements of the vessel, including the excitation for the propulsion machinery and the supply to engine auxiliaries. A discriminating protective system is arranged to interrupt the supply to non-essential services, if the load on the bus-bars exceeds the capacity of the generating plant that happens to be in service. The discrimination is entirely automatic and, of course, is capable of operating in the event of the essential services being endangered by a fault elsewhere on the system. The excitation supply is taken from the machine side of either of the 48-kilowatt generator circuit breakers, through a double-throw switch, to be seen on the centre panel of the board, the object being to eliminate all risk of a failure of excitation supply and thus to ensure that power is available at the propeller until the main engines actually stop.

As regards the auxiliary machinery, electricity for lighting and other services when the main engines are not running is provided by a Gardner four-cylinder hand-started compression-ignition oil engine, coupled to a Metropolitan-Vickers generator, and the engine also drives a Reavell air compressor, which supplies air for starting the main engines. A small motor-driven air compressor by the Hamworthy Engineering Company has also been installed on the ship. Cooling water for the engines is supplied by a Drysdale motor-driven vertical-spindle centrifugal pump, whilst for bilge and general service there are two motor-driven Mumford "Vertex" pumps. A Hopkinson fumeproof centrifuge is provided for purifying the fuel oil for the engines, and arrangements are made for it to deal with the lubricating oil when necessary. There is also a fuel oil transfer pump of the Ham worthy Engineering Company's Rotofoil type, for the various oil pumping requirements. For all the auxiliaries Metro-Vick motors are used. The steering gear is of the Hele-Shaw electro-hydraulic type, and the security of the motor circuit of this gear has received special attention. Instead of a starter of the usual type, a simple knife switch and fuse are used, for the motor has been designed so that it may be connected directly across the mains without the interposition of starting resistances. The steering circuit is completed through indicating appliances on the bridge and in the engine-room.

The vessel was built under the special survey of the British Corporation and to the full requirements of the Board of Trade. The general design of the ship and its machinery was prepared by Messrs. Graham, Robb and Woolnough, and the hull and machinery were built under their supervision. The trials of the vessel commenced on Monday, May 25th, and she was handed over to her owners three days later. During progressive trials on the measured mile, a speed of just over 16½ knots was obtained as a mean of a pair of runs with the engines at their normal rating and the contract deadweight on board.

Obituary.

MR. PERCY BROWN.

WE learn with regret of the death, on June 1st, at the early age of fifty-three, of Mr. Percy Brown, son of the late Mr. David Brown, who, in the year 1860, founded the firm of David Brown and Sons (Huddfd.), Ltd., Huddersfield, of which firm he was vice-chairman and joint managing director. He was also a director of the Société Française des Procedés David Brown and Sons, a new continental company formed for the manufacture of gearing in France.

Mr. Percy Brown was actively associated with the firm throughout the whole of his business life, and was known personally in a wide circle of the engineering profession. He played an important part in the development of gear design, particularly in connection with the design and construction of machines for gear production. Essentially practical, he had an intimate knowledge of every detail of manufacture and was ever keen and enthusiastic in applying any possible improvement for the better or more accurate production of every type of gear manufacture. When during the war the capacity of the Park Works was taxed to its utmost, Mr. Brown's experience and energies were evidenced in full measure. He was a member of the Iron and Steel Institute, the British Foundrymen's Association, and the Institute of Metals, and had always a generous sympathy with engineering and metallurgical research.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

MAIN LINE ELECTRIFICATION.

SIR,—The late Mr. Max Weiss, formerly the Chief Mechanical Engineer of the Swiss Federal Railways, expressed to the writer his amazement that engineers should hope to obtain completely satisfactory results from electrification, whilst adhering to the time-honoured practice of supporting the traction motors on nose and axle bearings.

Lord Monkswell apparently endorses this opinion, whilst the results achieved in recent practice indicate that the life of tires and of track can be extended by 100 per cent., chiefly by the elimination of the nose and axle support of the motor.

It is desirable that specifications for electric locomotives and for motor coaches should require the motors and the transmission gear to be so arranged as to ensure free play for the axle in the frame, under the control of the bearing springs, without causing momentary changes in the angular aspect of the rotating masses. J. D. TWINBERROW.

London, May 28th.

SPIRAL SPRINGS.

SIR,—Referring to the article on "Spiral Springs," which you published in THE ENGINEER for October 31st, 1930, I regret that equation (21) is incorrect.

Owing to a typing error which I overlooked, the first part of the equation reads

$$= \frac{E\,t}{2\,(r_1 - r_o)}$$

whereas it should read

$$= \frac{E\,t}{2}\left(\frac{1}{r_1} - \frac{1}{r_o}\right)$$

The second part of the same equation is correct. I am very sorry that this error has crept in, and trust you will deal with the matter as you think fit.

Hayes End, May 29th. E. C. WADLOW.

Books of Reference.

The Roadway Goods Transport Guide. Price 25s. Published under the auspices of the Commercial Motor Users Association by Roadway Time Tables, Bookings, and Publications, Ltd., 1, Warwick-street, Piccadilly-circus, W. 1, in conjunction with Temple Press, Ltd.—This is a volume of 978 large quarto pages, designed to form a link between the works or premises of any producer, manufacturer, or trader, and the available and suitable empty road vehicle. Some 750 pages are devoted to a directory of haulage contractors in England, Wales, Scotland and Ireland, arranged in alphabetic order of towns, and alphabetic sequence under each town. This directory gives the resources of each haulier in plant, the usual area of operation, regular services undertaken, and the branch depôts or agencies. London has its own section, divided into two parts, central and outer, with the names grouped under postal districts, and the position of the postal districts clearly indicated on a specially drawn map. Regular services of goods vehicles are shown by means of a comprehensive index, which discloses the fact that from 1380 principal towns and centres, in Great Britain, no fewer than 19,092 services connect with 10,866 other places. To and from London alone there are 2460 services, which serve directly 1050 towns in Great Britain. Another feature is the inclusion of specialised indexes, to show where to find suitable types of vehicles for special classes of haulage.

The Empire Municipal Directory and Year Book, 1931-32. London: The Sanitary Publishing Company, Ltd., 8, Breams-buildings, E.C. 4. Price 12s. 6d. net.—This year's issue of this up-to-date book of reference marks its forty-ninth year of publication. It is, like the volumes which have preceded it, brimful of information likely to be of service to municipal engineers and officers generally. There is more or less the usual arrangement of its contents, but we notice the addition of a new section. Those that it now embodies contain, first of all, a directory of local authorities and their officials, which claims to be, and we believe with warrant, the most complete list of its kind which exists in any one volume. Other sections deal with:—"Road Construction and Maintenance;" "Road Direction and Signal Signs"—a new section—"Municipal Motor Transport;" "Plain and Reinforced Concrete and Cement"; "Lighting, Heating, and Ventilation;" "Water Supply, Purification, and Softening;" "Sewerage and Sewage Disposal;" "Public Cleansing and Waste Utilisation;" "Fire Prevention;" "Housing and Town Planning;" "Labour-aiding Plant and Appliances;" "Public Recreation Grounds;" "Municipal and Public Health Law;" "Municipal Engineering, Public Health, and Scientific Societies;" and "Where to Buy: A Municipal Engineering and Sanitary Trades Directory." Then, at the end there is, as usual, a week-to-the-page diary. In the section devoted to "Municipal Motor Transport" there is an interesting list of the numbers and types of self-propelling vehicles owned and operated by numerous local authorities, together with the particular work on which they are engaged. This list will undoubtedly be of value to prospective purchasers of motor vehicles for municipal service. In fact, the whole volume appears to aim specially at being of assistance to the class of reader to which it particularly appeals.

BIRTHDAY HONOURS.

AMONG the Birthday Honours conferred by the King, the following names of engineers and scientists are to be found:—Sir William Henry Bragg, who has received the Order of Merit in recognition of his eminent services in the advancement of science; Mr. Philip Henry Devitt, chairman of Devitt and Moore's Ocean Training Ships, Ltd., and founder of the Nautical College, Pangbourne, upon whom a Baronetcy has been conferred; Mr. John Ferguson Bell, M. Inst. C.E., M.I. Mech. E., who has received a Knighthood for public services in Derby; Engineer Rear-Admiral Herbert Lyell Parry, who becomes a C.B. (Military Division); and Lieut.-Colonel Alan Henry Lawrence Mount, R.E. (Retd.), the Chief Inspecting Officer of Railways, Ministry of Transport, who becomes a C.B. (Civil Division).

Railway and Road Matters.

RAILWAYMEN will welcome the inclusion of the name of Lieut.-Colonel A. H. L. Mount, the Chief Inspecting Officer of Railways, in the birthday honours. Colonel Mount is made a Companion of the Bath.

THE trial of driver Eskdale on a charge of manslaughter, arising out of the Carlisle derailment of January 3rd, was commenced at Cumberland Assizes on Monday. It was concluded on Wednesday and resulted in a verdict of "Not Guilty."

THE coroner who inquired into the four deaths resulting from a motor car, on May 23rd, crashing into the gates of the Beddingham level crossing, Lewes, and fouling the path of an express from Brighton to Hastings, observed, in his directions to the jury: "It seems in this case that the driver of the car, by his lack of observation, not only killed himself and the three persons with him, but he endangered the lives of dozens and dozens of other people, and it was only by a special act of Providence that many people were not injured by this train being derailed, as it might easily have been, by passing over the *débris* of the car." A verdict of "Accidental death" was returned.

THE attachment and detachment of what the railway companies call blank doors at the outer end of the collapsible gangway, which gives access between corridor coaches, has always appeared to an observant traveller to be a job that was capable of less unwieldy handling. It is interesting, therefore, to hear that Messrs. Arthur L. Gibson, of Twickenham, who have made revolving doors for some of the engine sheds and carriage depôts of the Southern Railway, are equipping a roller shutter to take the place of these blank doors. An advantage would appear to be that whilst the latter can only be fixed or removed by men standing on the track, the revolving shutter can be raised or lowered from inside or outside the carriage.

ANOTHER change has been made in the annual returns of railway accidents. Up to and including the year 1902 these were issued separately from the annual report. In 1903, when Sir Herbert Jekyll became responsible for the report, both were combined in one document; but in 1908, when Sir William Marwood became head of the Railway Department, the two were again separated. That has since been the case except that in 1920, when, after the formation of the Ministry of Transport and Sir John Pringle took the report, the size of the pages of the report were reduced. Then, in 1923, after grouping, the returns were necessarily compressed. Now, the returns for 1930 appear in a "Preliminary Statement" as "Provisional Returns." The main figures, though, are given, but much of the detail is evidently left for Colonel Mount's annual report. The price is twopence.

THE Indian Railway Board, in its report for the year ended March 31st, 1930, says that poppet valves, in place of piston valves, were in use on three railways at the end of the year, and on order for four other railways. These valves are either of the Caprotti or Lentz type. On two railways the latter type of valve was actuated by existing Walchaerts gear, but it would appear that all future applications of these valves will be fitted with rotary gear. The results so far obtained had been satisfactory, and what troubles had been experienced had not been serious, and the results of experiments appeared to show that a saving of fuel will be possible by their use. The experiments were only in their initial stages, and it was too early to make a definite pronouncement as to whether it was desirable to extend the use of this type of valve, which at present was more expensive than the ordinary type of piston valve.

As a sequel to the grouping of railways under the Railways Act, 1921, powers were obtained to dissolve the Somerset and Dorset Railway Company and to vest the undertaking in the Southern and London, Midland and Scottish companies, which, as successors to the London and South-Western and the Midland, had been the lessees since 1876. One result of that has been that the London, Midland and Scottish Railway has taken over 80 locomotives, 40 coaching vehicles, 57 goods vehicles, and 114 "service" vehicles. The Southern Railway similarly have acquired 74 passenger carriages, 42 "other coaching" vehicles, and 57 "service" vehicles. A transaction of the same character has apparently occurred with the goods stock of the Cheshire Lines Committee—jointly owned by the London and North-Eastern and the London, Midland and Scottish—as the former company has taken over 2740 wagons and the latter 1371 wagons. We have not as yet seen any mention of the passenger stock of the Cheshire Lines. The only other joint concern that owns rolling stock is the Midland and Great Northern Joint Committee, which owns 98 locomotives, 166 carriages, 52 "other" coaching vehicles, 29 wagons, and 144 service vehicles.

THE coroner for East Dereham, on Thursday, May 28th, opened his inquiry into the death of the passenger killed the previous day in the collisions at Fakenham, and, after taking evidence as to identification, adjourned it until June 24th. Colonel Anderson, of the Ministry of Transport, made his investigation on Friday, the 29th, when, in view of what transpired, it should be noted that neither of the drivers concerned were able, owing to their injuries, to be present. The inspecting officer, as a consequence, said that as most of the witnesses that were available were men who might be prejudiced in subsequent proceedings, should their evidence be taken in public, the proceedings that day would be held in private, and then adjourned until the remaining witnesses were able to attend. Colonel Mauldin, superintendent of the eastern section of the Southern Area, London and North-Eastern Railway, however, made a statement as to what occurred on the day in question. Fakenham Station was opened on March 30th, 1849, when the line was extended from Dereham. It was, and still is, on a single line, and apparently the lay-out is the same as it was over eighty years ago, *e.g.*, a single platform on the down side with a through single line on the east and a bay line on the west. Colonel Mauldin said that the train from Wells arrived at 9.6, passed through the station on the single line, and was backed into the bay. The train from Dereham was then accepted and, from some cause not yet publicly known, was turned into the bay and collided with the Wells train.

Notes and Memoranda.

AN American collier recently unloaded herself at the average rate of 1000 tons an hour. She carries 6000 tons in hopper-shaped holds, beneath which there is a fore-and-aft belt conveyor. Two other conveyors at the bow deliver the coal overboard.

THE National Research Council of Canada is at present engaged in investigating the waste material accumulated in the grain elevators. The results already obtained indicate that the waste can be made to yield oil for soap-making, fertilisers, and possibly feeding-stuffs.

AT the end of 1930 about 3 per cent. of the German railway system was electrified. Bavaria possesses nearly 434 miles of electrified lines, Baden nearly 30 miles, Southern Silesia 216 miles, the Central-German lignite district nearly 117 miles, and the Berlin and Hamburg inter-urban lines 166½ miles.

A NEW phase in the activities of technical societies is marked by the taking out of patent rights by the American Institute of Steel Construction. The Institute has filed patent claims on the design of a steel guard rail for highways, to make sure that it can be used by all fabricators and erectors without fee and without extra charge to the public.

A FORM of welding rod has been produced by the American Manganese Steel Company, of Chicago Heights, which is reported to be well suited to the purpose of building up on the surface of steel articles to give them a good wear-resisting surface. The rods contain from 13½ to 14 per cent. of manganese, and are deposited by means of the electric arc.

INTENSIVE work on the deoxidation of steel with manganese-silicon alloys by the American Bureau of Mines has shown that the use of these alloys, which may be produced from domestic manganese ores, would decrease the ferro-manganese requirements of a very large tonnage of the steel produced in that country by 60 to 80 per cent., and in some cases by 100 per cent. The open-hearth heats made with these alloys have been of excellent quality.

IN discussing heavy plate construction in the *Contract Record*, Mr. W. D. Walcot, the testing engineer of the Hydro-Electric Power Commission of Ontario, says that there is considerable difference of opinion as to the necessity for bevel planing the edge of heavy plate with a view to caulking. It has been his company's experience that on heavy sections the rolled edge as it comes from the mill can be efficiently caulked without bevel planing, but where the edges have been sheared and are uneven planing is necessary. On the other hand, he recommends that the edges of plates cut by the acetylene blow-pipe should be machined away to the extent of about ¼ in.

A PAPER just published by the Fuel Research Station of the Department of Scientific Industrial Research contains a study of the methods of obtaining complete balance sheets in the commercial use of water gas as a fuel and as a source of hydrogen. It shows (*a*) the distribution, in the final products, of the carbon entering the plant, and (*b*) the amounts of heat generated in the process and its utilisation. A previous paper—"Fuel Research Technical Paper No. 27," published in 1930—describes the methods adopted for measuring the rapidly fluctuating flows of gas and air which occur in the process. The paper may be obtained from H.M. Stationery Office, price 9d.

A TRAGIC occurrence in a saw mill of Gloucestershire suggests the necessity for greater publicity in the findings of the official investigations under the Boiler Explosions Acts. A cast iron steam jacketed pan used for culinary purposes exploded and killed a man. It was proved that the bottom of the pan was originally stayed to the jacket by a central hollow stay, but that a fitter, the victim, had taken out this stay and blanked off the two openings with the idea of stopping a troublesome leak. The pan was so weakened that it exploded. Such a contingency is obvious to those with experience, and the broadcasting of the news of such an accident should help towards the education of those of less experience in the interference with apparatus which they do not fully understand.

AN instance of the merit of providing a bottom manhole to a tar still was mentioned by Mr. H. C. Dungey in a paper read before the National Safety First Association in Leeds. A man who had been told to remove the top manlid of a tar still in order that the foreman might inspect the still exceeded his instructions and entered the still. He was overcome by gas, and became unconscious before he could escape. Three other men successively entered the still to rescue him, but were all immediately gassed. The bottom manlid was removed with great haste by another man, and all four men were rescued in an unconscious condition. They were removed to a local infirmary, but were found very little the worse for their experience and were discharged the next day. There is not the slightest doubt that the bottom manlid of the still saved the lives of the four men concerned. It would have been impossible to remove four unconscious men through the top manhole of the still before it was too late.

A METHOD has been developed for the electro-deposition of metallic tungsten from aqueous solutions. It was described by C. G. Fink and F. L. Jones to the Electrochemical Society of America. The tungsten deposit is smooth, hard and coherent, having a high lustre. Like chromium, the electrodeposited tungsten needs no polishing if the plated article was previously polished. Tungsten has remarkable acid-resisting properties, which make it desirable as a protective coating for other metals. Several types of solutions have been investigated in regard to their usefulness as tungsten plating baths. Solutions of tungsten salts in organic solvents were found unsuitable for this purpose. Aqueous solutions of an acid nature did not give satisfactory metal deposits. Alkaline solutions containing alkaline tungstates were preferably used as plating baths. The temperature, cathode current density, and hydrogen ion concentration of the solution must be controlled. Alloys of tungsten and iron, and of tungsten and nickel, were electro-deposited from similar solutions containing very small concentrations of the ions of these second metals.

Miscellanea.

THE production of sulphuric acid in Belgium during 1929 was 800,000 tons, which shows a slight increase on previous years.

DURING 1929 there were felled over 3000 million cubic feet of standing timber. The resulting products were valued at 219,570,129 dollars.

TENTATIVE estimates, aggregating 1,000,000 dollars, for additional permanent improvements to the Fraser River Ship Channel have been filed at Ottawa.

THE first steel plate rolled in the mills of Dominion Foundries and Steel, Ltd., of Hamilton, has just been dispatched to Vancouver for the construction of a bridge.

THE Polish Government has decided to organise a factory for the manufacture of automatic telephone apparatus. It is expected to be in working order by 1933.

A LARGE plant for the manufacture of chemicals used in match manufacture such as sodium chlorate and potassium chlorate, is to be put up in the United States by the Diamond Match Company.

THE production of sodium sulphate from the dried-up lakes of the prairie provinces of Canada now amounts to well over 30,000 tons a year. A large part of it is used in the manufacture of sulphite paper pulp.

THE McLeod River in Alberta is to be dredged for gold. There are said to be 1,500,000 cubic yards of gravel available with a content of 17 cents of gold per yard. The dredge and its equipment will cost about £20,000.

TWO American airmen recently made a non-stop flight, without refuelling, of 84 hours, 33 minutes in an aeroplane equipped with a heavy-oil engine. The distance covered was approximately 6600 miles and the fuel consumed 333 gallons.

A BUST of Sir Robert Hadfield, who claims the distinction of being the only foreign honorary member of the Metallografiska Institutet of Stockholm, has just been unveiled at the Institute, in memory of his donation to the Society of four scholarships in metallurgy.

DURING last year the gas industries of the United States sold 408,000 million cubic feet of manufactured gas and 1,940,000 million cubic feet of natural gas. There were 16 million consumers, and the capital invested in the industry amounted to over £1,000,000,000.

THE extension of railway facilities in the Hudson Bay district of Canada has intensified the interest in the iron ore deposits of the Belcher Islands. These deposits are known to be rich and extensive, and there is also high-grade lignite in the district. The Government has reserved the mineral rights of the islands, in so far as they have not been already alienated.

WE learn from a report on the work of the Department of Petroleum Technology of the Sir John Cass Technical Institute for 1930–31, that Professor Brame's course on the Properties, Applications and Examination of Petroleum attracted a larger number of students than in any previous session, and in order to accommodate the students in the laboratory it was found necessary to provide three separate "practical" periods. The students' hours, in all the classes, numbered 4144, as compared with 2876 in the preceding session.

THE Council of the Institution of Mining Engineers has awarded the "Mavor and Coulson" Travelling Studentship of £300 for 1931 to John Kenneth Coultas, B.Sc. (Mining), Leeds University, of Wath-on-Dearne, Yorks. The successful candidate is required to devote one year to the special study by underground investigations of the methods practised in the actual mining of coal and in the transport of coal from the face to the main mechanical haulage, in Great Britain, the Continent of Europe, Canada, and/or the United States, and to follow a pre-arranged itinerary specifying the collieries to be visited.

THE Manchester City Council is again offering a number of scholarships tenable in the Faculty of Technology of the University of Manchester. Successful candidates are required to follow a full-time course leading to the degree of Bachelor of Technical Science in the College of Technology, and matriculation or its equivalent is an essential qualification. For students who have been engaged in industry, and who have attended part-time day or evening classes, the scholarships are of the value of £100 per annum, while for students leaving secondary or central schools the value is £60. Both classes of scholarships are tenable for three years.

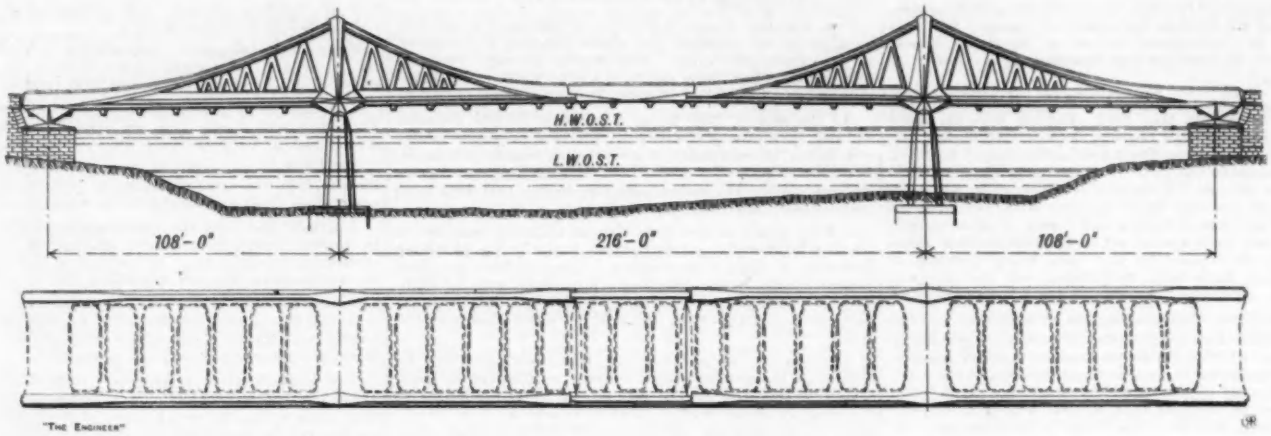
ENGLAND will be represented by an outstanding group of scientists and men of affairs at the Third International Conference on Bituminous Coal, which will be held at the Carnegie Institute of Technology in Pittsburgh, Pa., U.S.A., November 16th to 21st, 1931. Professor William A. Bone, of the Imperial College of Science and Technology, London; Dr. Cecil Lander, Director of the Fuel Research Board, London; Dr. R. Lessing, consulting chemist, of London; and Dr. W. H. Cadman, of the Anglo-Persian Oil Company, London, are among the group that have accepted the invitation of Dr. Thomas S. Baker, President of the Carnegie Institute of Technology and organiser of the conferences, to participate in the international meeting next autumn.

A FURTHER step in the co-ordination of the activities of technical societies has recently been taken by the formation of the Association of Secretaries of Engineering Societies in Glasgow. The membership is representative of 17 associations, comprising the national societies and the Scottish branches of all the important British societies, and the members have the full support of their respective committees. One of the objects of the Association is so to arrange the dates of meetings of the constituent societies that there shall be the minimum of interference between the various fixtures. It will also keep its members informed of the activities of the different societies. It is proposed to publish a joint programme of meetings, and to make reciprocal arrangements for attendance at meetings. The convener of the Association is Mr. P. W. Thomas, B.Sc. (Eng.), secretary of the Institution of Engineers and Shipbuilders in Scotland.

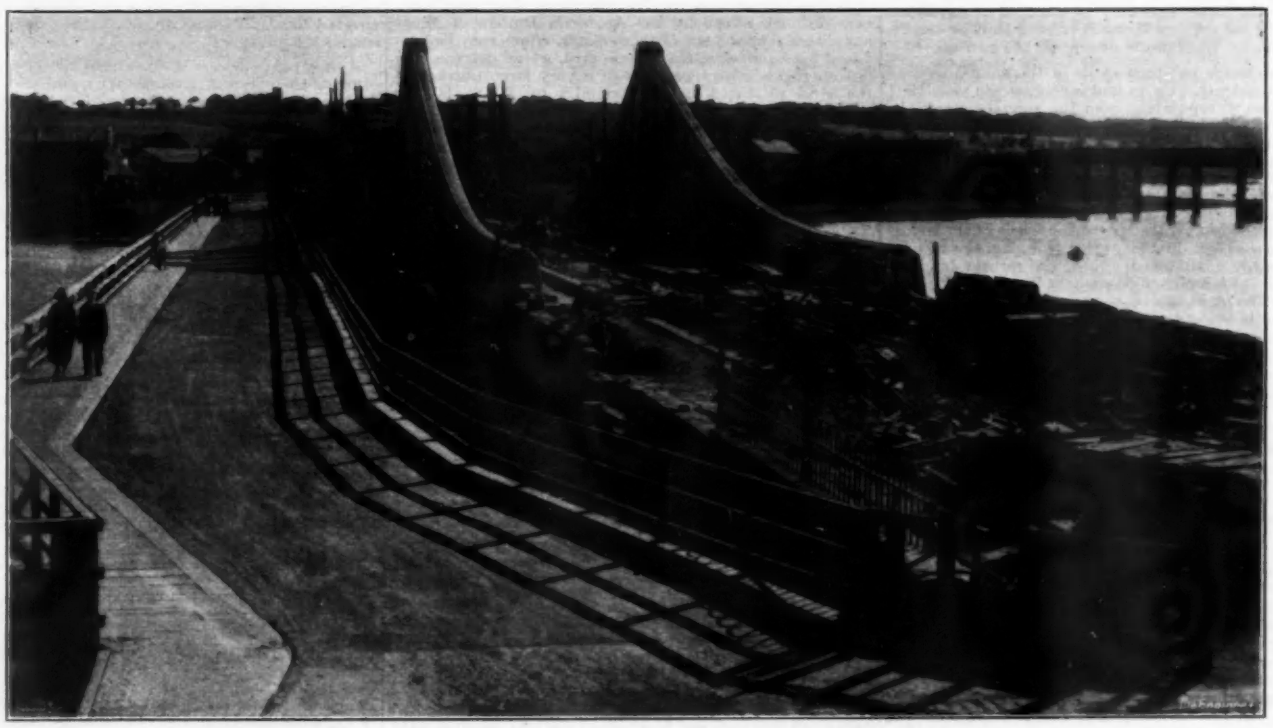
MONTROSE BRIDGE

SIR E. OWEN WILLIAMS, M. INST. C.E., ENGINEER

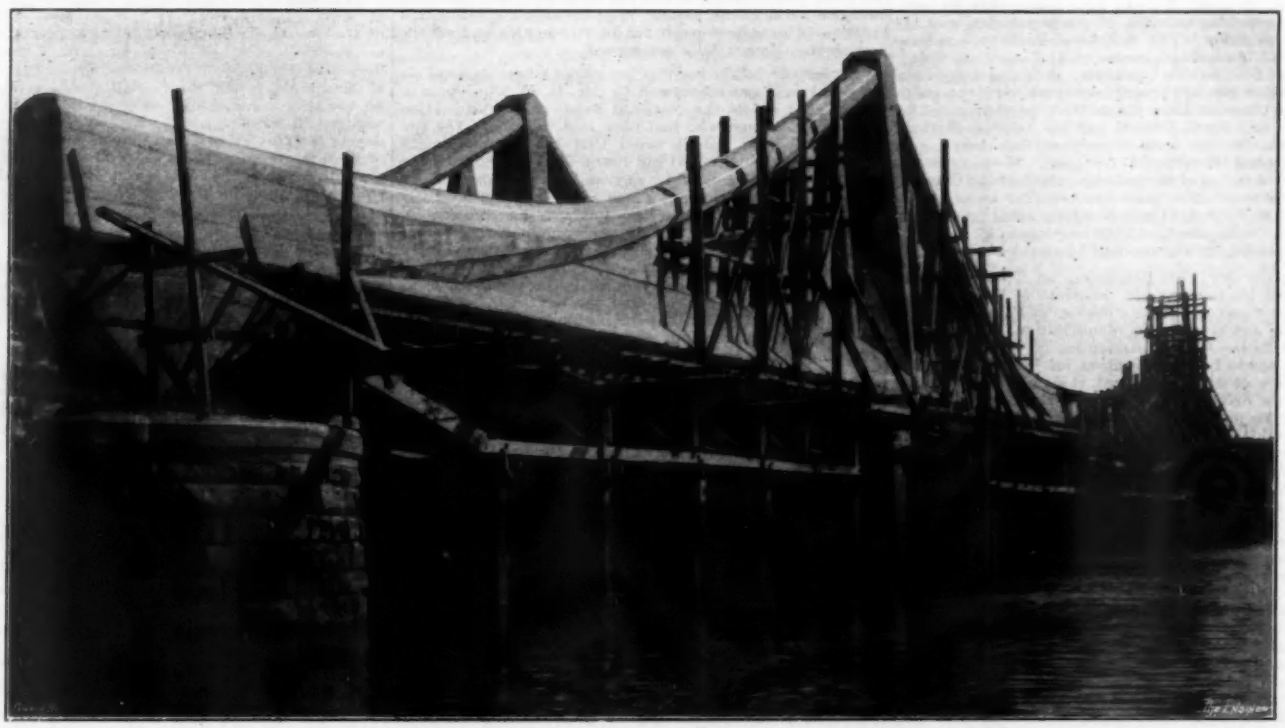
(*For description see page* 616.)



PLAN AND ELEVATION OF THE BRIDGE



VIEW OF THE WORK SHOWING THE TEMPORARY BRIDGE



VIEW SHOWING THE CENTERING

The Engineer

Annual Subscription Rates

(including postal charges).

Subscriptions will be accepted by the Publisher direct or through a newsagent at the rates and in the currencies stated below :—

BRITISH ISLES	£3	5	0	
CANADA	£3	3	0	Thick Paper edition.
	£2	18	6	Thin Paper edition.
ABROAD	£3	7	6	Thick Paper edition.
(except Canada)	£3	3	0	Thin Paper edition.

AFRICA	Central News Agency. All Branches
* £3 7s. 6d.	CAPE TOWN : Wm. Dawson and Sons, Ltd.
† £3 3s. 0d.	29–31, Long-street (Box 489)
	JOHANNESBURG : C. Juta and Co.
ARGENTINE	BUENOS AIRES : Mitchell's Book Store, 576,
* £3 7s. 6d.	Cangallo
† £3 3s. 0d.	
AUSTRALIA	Gordon and Gotch (Australasia), Ltd. All
* £3 7s. 6d.	Branches
† £3 3s. 0d.	MELBOURNE : Robertson and Mullens,
	Elizabeth-street
BELGIUM	BRUXELLES : E. Graddon, 78, Rue du
* Fr. 590	Marché-aux-Herbes
† Fr. 550	BRUXELLES : W. H. Smith and Son, 78–80,
	Rue du Marché-aux-Herbes
CANADA	American News Company, Ltd. All Branches
* $15·25	MONTREAL : Gordon and Gotch, Ltd., 334,
† $14·25	Notre Dame-street, W.
	TORONTO : Wm. Dawson and Sons, Ltd., 87
	Queen-street East
	TORONTO : Gordon and Gotch, Ltd., 81
	Queen-street West
CEYLON	COLOMBO : Wijayartna and Co.
* Rs. 44·5	
† Rs. 41·5	
CHINA	HONG KONG : Kelly and Walsh, Ltd.
* $37	SHANGHAI : Kelly and Walsh, Ltd.
† $34·5	
EGYPT	CAIRO : Express Book and Stationery Store,
* £3 7s. 6. (Pt. 330)	9, Chareh Maghrabi
† £3 3s. 0d. (Pt. 308)	
FINLAND	HELSINGFORS : Akademiska Bokhandeln,
* M. 650	Alexandersgatan, 7
† M. 605	
FRANCE	PARIS : Boyveau and Chevillet, Rue de la
* Fr. 418	Banque, 22
† Fr. 390	PARIS : Librarie Berger-Leverault, 229, Bld.
	St. Germain
	PARIS : Brentano's, 37, Av. de l'Opera
	PARIS : Dunod, 92, Rue Bonaparte
	PARIS : W. H. Smith and Son, 248, Rue de
	Rivoli
GERMANY	BERLIN-LICHTERFELDE-WEST : H. Her-
* R. mks. 70·00	manns, Dahlemer Strasse 64 A
† R. mks. 65·00	LEIPZIG : K. W. Hiersemann, Konigstrasse 29
HOLLAND	ROTTERDAM : Hector's Boekhandel, Noord-
* Fl. 41·00	blaak 59
† Fl. 38·00	ROTTERDAM : Techn. Boekhandel, "Plan C,"
	Gelderschestraat 4
INDIA	BOMBAY : Thacker and Co., Ltd.
* Rs. 45	CALCUTTA : Thacker, Spink and Co.
† Rs. 42	
ITALY	MILAN : Ulrico Hoepli
* Lire 300	ROME : Maglioni and Strini, 307, Corso
† Lire 280	ROME : Fratelli Treves, Corso Umberto I, 174
	ROME : Fratelli Bocca
	TURIN : Rosenberg and Sellier, v. Maria
	Vittoria 18, and their Branches at Naples
	and Rome
JAPAN	Maruzen Co. All Branches
* £3 7s. 6d.	
† £3 3s. 0d.	
JAMAICA	KINGSTON : Educational Supply Co.
* £3 7s. 6d.	
† £3 3s. 0d.	
NEW ZEALAND	AUCKLAND : Whitcombe and Tombs, Ltd.
* £3 7s. 6d.	Gordon and Gotch, Ltd. All Branches
† £3 3s. 0d.	NAPIER : J. Wilson Craig and Co.
RUSSIA	LENINGRAD : Mezhdunarodnaya Kniga, Pros-
* £3 7s. 6d.	pect Volodarsky, 53 A
† £3 3s. 0d.	MOSCOW : "Litisdat," Koumetsky Most, 5-15
STRAITS SETTLEMENTS	SINGAPORE : Kelly and Walsh,
* $29·25	Ltd.
† $27·25	
SWEDEN	STOCKHOLM : A/B Wennergrens Journal-
* Kr. 61·00	expedition, Stockholm 1
† Kr. 57·00	STOCKHOLM : A/B C. E. Fritzes Kungl.,
	Hofbokhandel, Fredsgatan, 2
SWITZERLAND	BERNE : Joh. William De Groot, Laupenstr. 5
* Fr. 85·20	ZURICH : Rosa Leibowicz, 4, Ankerstr.
† Fr. 79·50	
UNITED STATES OF AMERICA	International News Co., 131, Varick-street, New York, N.Y., and all Branches
* $16·40	Entered as second-class matter at the Post Office,
† $15·25	New York, N.Y., December 12th, 1896, under the Act of March 3rd, 1879 (Section 397, P.L. & R.)

* *Thick Paper.* † *Thin Paper.*

These rates are liable to alteration if exchange fluctuations require it.

*** READING CASES, *to hold two copies of* THE ENGINEER, *cloth sides and leather backs, can now be supplied at 4s. 9d. each, 5s. 3d. post free.*

"THE METALLURGIST."

This Supplement, which deals with the Science and Practice of Metallurgy, both ferrous and non-ferrous, is published free with the last issue of THE ENGINEER in each calendar month.

ADVERTISEMENTS.

The charge for Classified Advertisements is 1/- per line up to one inch—minimum charge 4/-; those occupying one inch or more at the rate of 12/- per inch. Orders must be accompanied by a remittance. The rates for Displayed Advertisements will be forwarded on application. Classified Advertisements cannot be inserted unless delivered before TWO o clock on Thursday afternoon (the day before publication).

Letters relating to the Advertisement and the Publishing Department of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

THE ENGINEER DIRECTORY.

This Directory, which is published annually in the interests of advertisers in THE ENGINEER, may be obtained free of charge on application to the Publisher.

Postal Address, 28, Essex-street, Strand, London, W.C. 2.
Teleg. Address, "Engineer Newspaper, Estrand, London."
Tel.: Central 6565 (8 Lines).

By arrangement with Reuter's Engineering Service, THE ENGINEER *contains the latest news from all parts of the world which is likely to be of interest to engineers.*

Contents.

THE ENGINEER, June 5th, 1931.

	PAGE
A SEVEN-DAY JOURNAL	615
MONTROSE BRIDGE. (Illus.)	616
NEW FISH DOCK, GRIMSBY. (Illus.)	619
BIGGER WAGONS FOR BRITISH RAILWAYS	620
A NEW AUSTRALIAN LOCOMOTIVE WORKS. (Illus.)	621
THE ELECTRICALLY PROPELLED MOTOR SHIP "LOCHFYNE." (Illus.)	623
OBITUARY—Percy Brown	626
LETTERS TO THE EDITOR—	
Main Line Electrification—Spiral Springs	626
BOOKS OF REFERENCE	626
BIRTHDAY HONOURS	626
RAILWAY AND ROAD MATTERS	627
NOTES AND MEMORANDA	627
MISCELLANEA	627
LEADING ARTICLES—	
The Comparison of Steam Turbines	629
Dr. Enström on Research	630
LITERATURE	630
BOOKS RECEIVED	631
SIXTY YEARS AGO	631
MILLING MACHINE FOR TUNGSTEN CARBIDE CUTTERS. (Illus.)	632
RESEARCH IN INDUSTRY AND RATIONALISATION	632
OVER-VOLTAGE PROBLEMS. (Illus.)	634
A SELF-PRIMING PUMP. (Illus.)	636
VICKERS' SHOWROOM	636
SOUTH AFRICAN ENGINEERING NOTES	636
FLOATING DOCK FOR WELLINGTON, NEW ZEALAND	637
THE NEWCOMEN SOCIETY	637
PROVINCIAL LETTERS—	
The Midlands and Staffordshire—Lancashire	637
Sheffield—North of England	638
Scotland—Wales and Adjoining Counties	639
CATALOGUES	639
CURRENT PRICES FOR METALS AND FUELS	640
FRENCH ENGINEERING NOTES	641
BRITISH PATENT SPECIFICATIONS. (Illus.)	641
FORTHCOMING ENGAGEMENTS	642
PERSONAL AND BUSINESS ANNOUNCEMENTS	642
CONTRACTS	642

NOTICES TO READERS.

*** *If any Subscriber abroad should receive* THE ENGINEER *in an imperfect or mutilated condition, he will oblige by giving prompt information of the fact to the Publisher, with the name of the Agent through whom the paper is obtained. Such inconvenience, if suffered, can be remedied by obtaining the paper direct from this office.*

*** *All letters intended for insertion in* THE ENGINEER *or containing questions should be accompanied by the name and address of the writer, not necessarily for publication, but as a proof of good faith. No notice whatever can be taken of anonymous communications.*

*** *No undertaking can be given to return drawings or manuscripts; correspondents are therefore requested to keep copies.*

THE ENGINEER.

VOL. CLI No. 3934

JUNE 5, 1931.

The Comparison of Steam Turbines.

FOR many years the steam consumption per kilowatt-hour of a turbo-generator was considered to be an adequate measure of its efficiency. The comparison of different machines on the basis of steam consumption had the merit of simplicity, besides giving at the same time a fair idea of the demands of each on the boiler-house and condensing plant. But with sufficient advantage in the matter of pressure, temperature, or vacuum an intrinsically inferior machine might easily show a lower steam consumption than one of better design. Hence the need for some more fundamental basis of comparison soon made itself felt. Then there arose the idea of adopting as a criterion the theoretical performance of a perfect heat engine working under the same conditions as the actual machine. A perfect heat engine is often defined by giving a list of all the faults which it does not possess. For our present purpose it can best be considered simply as an engine which turns into useful work the whole of the heat it receives, with the exception only of that which is unavoidably rejected in the exhaust. In other words, it is as perfect as any heat engine can be which has to work under the limitations imposed by the Second Law of Thermodynamics. The performance of such an engine is obviously the ideal to which the actual turbine aspires, the measure of attainment being denoted by the somewhat awkward term "efficiency ratio." So far, everything is simple. The trouble begins when we want to come down to figures. Before we can calculate the performance of our ideal engine, it is necessary to stipulate the cycle according to which it shall be supposed to deal with the heat. The ideal-ness of the engine having been assumed, the name of Carnot comes at once to the mind, for whatever else an engineer may have forgotten, the perfection of the Carnot engine and the Carnot cycle remain ineffaceable in his memory. The Carnot cycle may, however, be dismissed at once, because it cannot be carried out, even theoretically, by any engine using a working fluid which is condensed during the cycle. Rankine met this difficulty by imagining that the working fluid was restored to its initial condition, not by adiabatic compression, as in the Carnot engine, but merely by being heated up again in a boiler. The efficiency was less than that of the Carnot process, because the heat was not all put into the fluid at the maximum temperature, but the Rankine cycle, nevertheless, corresponded to the best possible performance of an ideal simple steam plant, comprising only a boiler, with or without economiser and superheater, a turbine and a condenser. Hence it became recognised as the standard, and the efficiency ratio of an actual turbine was understood to mean the ratio of the efficiency of the latter to the efficiency of an ideal turbine working on the Rankine cycle with the same steam conditions.

Useful as was the idea of the Rankine cycle, it never quite correctly represented the sequence of operations, even in a simple steam plant. According to the cycle, the condensed steam should be pumped directly into the boiler or economiser at the condenser temperature, a procedure which would in practice be most inadvisable. Hence feed-water heating by means of waste steam from the auxiliaries was always adopted. This involved the whole principle of regeneration, and therefore constituted a distinct abandonment of the Rankine cycle. So long as the preliminary heating of feed water in this way was confined to giving it only a slight rise in temperature, the illogicality of comparing the performance of an actual plant with that of an ideal Rankine engine could pass unnoticed. But when, with the progress of design, the practice of heating the feed water by steam drawn from successive stages of the turbine was introduced, the inadequacy of the Rankine cycle to represent the sequence of operations was evident. Some other cycle had to be taken as the criterion of perfection, and thus arose questions about which as yet there is no agreement. Indeed, with the growing complexity of steam plant and the prospect of binary fluid turbines in the future, the difficulty of deciding what the term efficiency ratio does mean or ought to mean becomes greater rather than less. The matter may be illustrated by a simple example. Suppose an actual turbine is bled to heat the feed water regeneratively by, say, three successive stages, ought its performance to be compared with that of an ideal turbine doing feed heating in exactly the same way, or should the true criterion be an ideal turbine carrying out a theoretically perfect process of regenerative feed heating? There are good arguments on both sides. In support of the first alternative it may be claimed that the decision to heat the feed water in three specified stages lays down the conditions which define that part of the thermal cycle, hence to make a comparison on any other basis is to set up as an ideal something which the designer never wished to aim at. It would, from this point of view, be a proceeding as arbitrary as making him compare the performance of his turbine with that of an ideal turbine working under different specified steam conditions. Furthermore, if the criterion of perfection is to be a cycle with completely regenerative feed heating, how is the latter to be defined? No system of bleeding can, even theoretically, raise the feed-water temperature to that of the water in the boiler. Those who would favour the second alternative have also an arguable case. They might reasonably maintain that every turbine employing the regenerative principle at all ought to be compared with an ideal turbine in which the principle was carried out to perfection. The difficulty as regards the raising of the feed water to the full boiler temperature, as required in the ideal case, could be got over by assuming that some of the bled steam could be raised to the temperature and pressure necessary for this duty by means of adiabatic compression. It might be further claimed that the adoption of completely regenerative feed heating as an ideal is the proper practical recognition of its advantages, besides rendering the comparison fairer as between more and less perfect approaches to it. Feed heating is not the only question that presents difficulty. There is room for an analogous difference in opinion with regard to the manner in which steam reheating cycles should be treated. Reheating, in the limit, is an endeavour to approximate to an isothermal expansion, and so it might be contended that every actual reheating cycle should be appraised according to the nearness of its approach to this ideal.

Enough has been said to demonstrate the difficulties that may arise in the attempt to compare turbines on the basis of their efficiency ratios.

The report of the Heat Engine Trials Committee, published by the Institution of Civil Engineers only four years ago, requires that the efficiency ratio shall be stated in the case of every turbine test, whether of a comprehensive or industrial character. Although the directions given for calculating this ratio are intended to be explicit, there is room for considerable doubt as to what they really mean. They certainly seem to imply that the "efficiency of the standard engine of comparison" on which the efficiency ratio is based ought to be calculated as if the engine were working on a pure Rankine cycle without either regenerative feed heating or reheating of the steam. On the other hand, an introductory chapter on "Standards of Thermal Efficiency" contains worked out examples to illustrate the calculations for standard engines of comparison working on various modern cycles. In these examples the ideal engine is assumed to be working in each case on the same cycle as the turbine to be compared with it, whereas those who saw the report as first printed in its provisional form will remember that completely regenerative feed heating was then taken as the standard for comparison. These facts tend to show the variety of opinions which may be held in connection with the term efficiency ratio. The term has, indeed, lost so much of its definiteness, and therefore of its value, that the difficulty of maintaining the underlying idea in any useful manner has driven engineers back to fundamentals. Instead of taking as their criterion the performance of a perfect turbine, as limited by the Second Law of Thermodynamics—for this is really at the basis of the notion of efficiency ratio—they have returned to the axiom stated in the First Law. According to the latter and to the accepted values of units, a kilowatt-hour is the exact equivalent of 3412 B.Th.U. Hence a perfect turbine might be regarded as one which would consume no more than this amount of heat for every kilowatt-hour it produced. Actual turbines could thus be compared with perfection, and with each other by stating their heat consumptions per unit of useful work, regardless altogether of their steam conditions, heat cycles, or anything else. The method has the obvious disadvantage of setting up a standard of efficiency far too high to be even theoretically obtainable, owing to the neglect of the restrictions upon heat conversion which are imposed by the Second Law. It does, however, restore one of the practical features of the old method of measuring efficiency by means of steam consumption, for it enables a very good idea to be obtained of the amount of coal required to produce the power by means of the plant in question.

In spite of the drawback of holding up as an ideal a standard of efficiency which must be theoretically unattainable until condensers can work at the absolute zero of temperature—when, it may be noted, every perfect turbine would have the same efficiency, regardless of its initial steam conditions—the method of comparing turbines on the basis of their heat consumptions is coming more and more into use. On the Continent heat consumptions rather than steam consumptions have to be guaranteed in the contracts for all important plants. The same tendency is to be observed in this country. It was illustrated by Mr. C. D. Gibb's recent paper on "Land Turbine Development" before the Institution of Mechanical Engineers, in which the performances of all the machines considered were measured by their heat consumptions. Although the turbine designer, in striving after perfection, will always have a use for the conception of efficiency ratio, defined by himself to suit his particular needs, it appears that the term will drop more and more into disuse before the greater practical convenience of comparing turbines by their consumptions of heat per unit of useful work.

Dr. Enström on Research.

In a short paper which he read before the Society of Swedish Engineers in Great Britain last week, and which we reprint on page 632, Dr. Enström, Director of the Swedish Academy of Engineering Research, offered not only a new means of distinguishing between pure and applied research, but commented from a life experience upon the intrinsic value of both kinds. Without falling into the common error of supposing that once we have given a name to a fact we understand it, we must admit that accurate nomenclature does a great deal towards cleaning up confusion, for it is a common experience that the foundation for many discussions is no more than the lack of clear definition. Once a definition has been found, the difference between the disputants falls to the ground, and they discover that they are in accord. Hitherto we have had to distinguish between applied research, and research which is vaguely called scientific, or pure research, or pure scientific research, because it has no definite useful objective. Dr. Enström suggested a more concise definition. "Generally speaking," he said, "we differentiate between pure science and technical or applied science. Both seek the truth. The former endeavours to increase knowledge without taking into consideration the nature of the result; the latter works with the object of attaining a given practical goal. Within each branch one can proceed in different ways. I should like to differentiate between *spontaneous* research and *systematic* research. The former is perhaps most usual in pure science; the latter in technical research."

No one, least of all Dr. Enström, will pretend that the differentiation completely separates the two kinds of research. Faraday's inquiries were certainly systematic, but about the useful application of them the great natural philosopher never troubled his head. In mechanical engineering there are numerous examples of spontaneous discoveries made in the course of experiments. A classical example is the sudden improvement of the Newcomen engine by an accidentally applied internal jet of water. It was so remarkable that in the opinion of the contemporary historian Triewald, it could only have been due to the direct interposition of Divine Providence for Newcomen was a man without college education! Another case is the increased efficiency of an early propeller by the breaking away of part of its length, and yet another may be found in the history of the "Sirocco" fan. One might add almost indefinitely to the list of accidental discovery by widening the scope of inquiry. Such fortuitous improvements must not be looked upon lightly, for, after all, very many of the advances, not only of technology, but of science itself, have resulted from the intelligent pursuit of hints given by some accidental event. In such cases we are often on the borderland between pure and applied research. They may, as Dr. Enström thinks, be more usual in pure science than in technical research, but, as we have suggested, examples of "spontaneous" discoveries are not uncommon in the applied field. Yet that fact does not substantially weaken the differentiation proposed by Dr. Enström, and it is well that its significance should be observed. We hear in this country a great deal about the great research laboratories of America, and many people are led to believe that they are vastly enlarged examples of the research laboratories of our own famous physicists and chemists. They are, in fact, nothing of the kind. A few workers in them are engaged upon "spontaneous" research, but many times that number upon the "systematic" development of inventions. A great deal of the work is done by the "hit and miss" or "trial and error" method, which Edison brought to perfection, and it is doubtful if it deserves the name scientific at all. Of the value of such work there is no manner of doubt, and we do not intend to depreciate in the least the American laboratories when we attempt to remove a false impression as to their nature. Dr. Enström drew, as an example, a neat distinction between the "spontaneous" discovery of the X-ray by Röntgen and the work of Hertz, who, "starting from the assumption that according to Maxwell's equations electric waves should exist in Nature, searched for and found them by means of systematic experiments." The latter seems to be the higher, but when we recall how many of the real amenities of mankind are due to "spontaneous" research, we are obliged to recognise that, as much may result from the intelligent grasp of fortuitous events, the seizing of some little hint offered by accident, it is difficult to say that either branch of research is greater than the other.

The truth is that we stand in need of both. Difference does not turn, or should not turn, upon their respective merits. Indeed, as Dr. Enström pointed out, scientific methods and instruments are becoming more and more necessary in technical research, and the space which separates the pure scientific researcher and the technological researcher tends to become narrower. Yet as practical people, we cannot be surprised if directors and their shareholders show greater interest in the prosecution of systematic research directed towards the accomplishment of a specified purpose which is known to have economic value than in the speculative research which has no ulterior aim other than the discovery of some new fact, and is indifferent as to its commercial value.

Literature.

Uniflow, Back Pressure, and Steam Extraction Engines. By Eng. Lieut.-Com. T. ALLEN, R.N. (S.R.), M.Eng., M.I. Mech. E. Sir Isaac Pitman and Sons, Ltd. 42s. net.

BRITISH engineering literature, while it includes excellent books on the thermodynamic and mechanical principles underlying the action of the steam engine, is lacking in works written specially for the designer. Such books, while not neglecting scientific principles, should give in detail the methods by which the dimensions of engines to meet specified conditions can best be chosen, having regard to economy of manufacture as well as economy of operation; should show how the performance of the engines can be predicted; and should describe and illustrate engines and details representative of up-to-date practice.

In these respects Lieut.-Com. Allen's book is on the whole successful, and its value is by no means confined to the particular types named in its title. It is also worthy of welcome because uniflow, back-pressure and extraction engines have not hitherto been adequately dealt with in English literature, and because the great economies which can be effected by using the two latter types in combining the production of power and the provision of steam for process purposes are even yet not sufficiently widely appreciated.

In an introductory chapter particulars of typical engines are given, the application of back-pressure and extraction engines in various steam consuming industries is described, and the advantages of these systems are set forth.

The following chapters are devoted to factors fundamental in engine design. For single-expansion cylinders of the four-valve type—*i.e.*, having exhaust valves and not exhaust ports, like the uniflow—calculations of mean effective pressure are based upon a specified form of indicator diagram approximating to the probable actual diagram. The method of calculation is very fully described and the results obtained for different initial and exhaust pressures, superheats and cut-offs, are given in comprehensive tables and graphs. The steam consumption for the specified diagrams is then arrived at by first computing the "hypothetical steam consumption" from the quantity of steam represented by the diagram and the M.E.P., and then adding correction factors for the estimated losses by cylinder cooling and by leakage. These are based on the voluminous work of Hrabák, which is probably here for the first time made available in English. For uniflow engines also, tables and graphs of M.E.P. and steam consumption are given, but unfortunately in this case the details of the diagrams assumed are not stated, nor is it stated how the steam consumption figures have been ascertained. It is only by inference from their use later on that it appears that they are "probable actual" and not hypothetical figures.

The design of the principal mechanical details of engines is discussed, and there are chapters on condensing plant; governors for speed and pressure regulation; and on fitting, erecting and testing, whilst, throughout, descriptions of engines and details as made by leading English and continental firms are given. For the most part the design calculations are presented in minute detail, but a serious omission is that no mention is made of inertia stresses, which, in connecting-rod bolts, for example, are of the utmost importance.

A particularly valuable feature of the book is the description of a system of standardisation of sizes of engines and details, with consequent economy in manufacturing.

The descriptive portions of the book are unequal in quality and somewhat lacking in proportion. For certain details the illustrations are too small for clarity, and in comparison it seems out of place to devote a full page—page 582—to the illustration of a tachometer of standard type.

The text of the descriptive matter is sometimes deficient in lucidity. For instance, the "retrograde movement"—page 566—fitted to the Sulzer servomotor in order to effect rapid regulation requires explanation, and on page 368 the reference to fitting a governor with a rod having an elongated hole to open an auxiliary steam valve is not likely to convey much to those who are not already familiar with such a device.

The arrangement of the book is not all that could be desired. If the description of the governing system of an extraction engine which appears on page 538 had preceded the descriptions of details of such systems given on previous pages, the uninitiated reader would understand much better the functions of these details. Then there is a large amount of redundancy. This is no doubt due in some instances to the inclusion of material provided by different firms, part of which covers common ground; but that cannot explain the repetition on page 557 of the description of the same pressure governor which is described on pages 474 to 476. Certain factors relating to the application of back-pressure engines, in particular the loss of economy if such engines have to work at loads at which only a part of their exhaust can be utilised, are repeated with somewhat tiresome frequency.

On pages 43 and 44 Lieut.-Com. Allen endorses the widely held view that superheated steam is a less effective heating agent than saturated steam. Under the usual conditions of heating coils, in which the flow into the coil is determined by the rate at which the steam condenses and is removed by steam traps, this view is fallacious, and proof of its error has recently been afforded by investigations made and published in Germany.

The engines illustrated in the book are representative of modern practice, but it may be mentioned that while all the horizontal compound extraction engines described have uniflow low-pressure cylinders, this need not necessarily be the case, and, in fact, one first-class firm at least adopts the four-valve type of low-pressure cylinder unless the uniflow is specified. The four-valve cylinder is shorter and its use cheapens the engine. These advantages outweigh the slightly increased steam consumption. For the low range of pressure in a low-pressure cylinder the difference of steam consumption of the two types is not great; moreover, in an extraction engine, the proportion of load taken by the low-pressure cylinder is less, and at large extractions very much less, than in ordinary compound engines, so that economy in this cylinder is of relatively less importance.

In a future edition—which, it is hoped, may be called for—the comfort of the reader would be catered for if more of the illustrations could be arranged so as to be studied without the book having to be turned sideways, if insets were on folding sheets opening clear of the pages, and if the numerous references to tables and figures were accompanied by the reference to the page to facilitate turning them up. One mentions these minor defects since the book is so good that a further improved edition would be desirable. It is well printed and profusely illustrated.

In spite of the points criticised, it must be emphasised that the book is a very welcome one, is written from the right point of view, and will be of great interest and service to designers, works engineers, students, and the managers of factories in which steam is used for process purposes.

Agricultural Machinery. By J. BROWNLEE DAVIDSON, B.S., M.E., A.E. London: Chapman and Hall, Ltd. 1931. 17s. 6d.

IN the preface to this volume the author, who is Professor of Agricultural Engineering in Iowa State College, states that the principal objective pursued in its preparation was the development of a suitable text to aid in teaching the subject of agricultural machinery and that the needs of those who expect to use and manage that kind of plant were kept constantly in mind. He hopes also that the volume may be useful to students in agricultural engineering, and to designers and manufacturers of machines.

Although the book contains nearly 400 pages, only a selected number of the more important machines in use in the United States are described, and there are chapters of general engineering interest dealing with mechanical principles, the elements of machines, the transmission of power, measurement of power, friction and lubrication, and the materials used in the construction of machines. As it is claimed that agriculture employs one-fourth of the population of the United States, there should be a wide field for such a book in America alone.

The introduction of agricultural machinery has been the most significant feature of the development of agriculture in America, and although from time to time alarm has been expressed at the decline of the agricultural population and the threat of a shortage of agricultural production, just as in this country, since the introduction of machinery the increase in the output of agricultural products has more than kept pace with the increasing population. Not only has the production per worker been increased many times by the aid of machinery, but the conditions surrounding farm labour have been greatly improved. While the average farm day for field work seldom exceeds nine hours, wages have been increased by over 100 per cent. As regards the well-being of the farmer, the introduction of machinery has had a most important and beneficial effect. The yields of crops have been greatly increased, and their quality improved, although not in the same proportion, we are told, as the productive output of the farm worker has been raised.

Some idea of the magnitude of the agricultural machinery industry of the United States may be gathered from the census made by the U.S. Department of Commerce in 1926. In that year the value was over £90,000,000, of which nearly £16,000,000 worth was exported, or roughly twelve times as much as is exported from the United Kingdom. The State of Illinois is responsible for the major portion of the production. The most recent development of this industry is the formation of gigantic companies by the combination of numbers of smaller manufacturers until there are at the present time seven great concerns, each of which produces a "complete line of machines"—that is, all the machines in common use. It would appear from this development that economy in production and distribution is effected, and although it is sometimes urged that the formation of these large "combines" retards the development of new machines, this argument is met by the reply that it is only by the joint efforts of such companies that the necessary experimental and research work can be carried out effectively.

Although many of the machines and appliances which the author describes are of universal application, the larger number of them are made and used only in the United States. But there is much useful information on subjects of common interest, such, for instance, as the mechanics of the plough and the functions of the modern threshing machine, that will repay study by the student of agriculture. The harvester-thresher has a chapter to itself. This machine can only be used with advantage in countries where grain is allowed to become fully ripe in the field, and where it is either not necessary to harvest the straw, or where the saving of the straw is a matter of secondary importance. These conditions do not apply in this country. There are chapters on mowing machines; machines for making and handling hay; cotton growing, picking, and processing machinery; machines for planting and digging potatoes; dairy machinery; grain cleaning, grading, and separating machines; farm vehicles, and general information on the life and cost of agricultural machinery. The author has, however, devoted singularly little space to agricultural motor vehicles, and in view of the large numbers of tractors and wagons which are now in use in all parts of the world, his remark that "the first cost and cost of maintenance appear to be the obstacles to their use," reads strangely. If further editions of the book are called for, the author will do well to treat the agricultural tractor more fully than he has done in the present volume. The value of the book would also be greatly enhanced if some of the more important illustrations were larger, especially those which include detail drawings and dimensions. Many of these are quite undecipherable.

Strength of Materials. S. TIMOSHENKO. Two vols. Part I.: Elementary Theory and Problems. Price 15s. Part II., Advanced Theory and Problems. Price 18s. London, 1931: Macmillan and Co., Ltd.

THE developments of recent years in light structures and high-speed machinery have compelled designers to attempt a more complete analysis of the stresses produced in the parts of structures and machines by static and dynamic forces; and there has been, concurrently, a serious attempt to obtain a more complete knowledge of the properties of materials and their method of failure under stress. Between the standard works on elasticity and the ordinary text-book dealing with the strength of materials the gap, until recent years, has been wide, but it is more and more coming to be recognised that for the needs of to-day and particularly for the understanding of new problems, mathematical theory and experimental knowledge must assist and supplement each other in such a way as to be a safe guide for designers. Changes are taking place so rapidly that they cannot depend upon empiricisms, derived from experience only, to assist in the next step.

The two volumes before us represent a serious attempt to apply the present theoretical and experimental knowledge of the strength of materials to practical problems.

Volume I. commences with an elementary approach to the subject of elasticity, tensile tests, load strain diagrams and working stress. Problems are worked out involving tension and compression and calculations for the elastic displacement of points on simple structures under known applied forces, the weights of the elements of the structure being given. The author then immediately considers simple statically indeterminate problems and shows how from consideration of the elastic deformations and the statical conditions the forces in the elements can be obtained. Simple structures, compound elements, such as a bolt and tube, strained axially, and tubes of different metals shrunk on to each other at elevated temperatures, are considered. The chapter concludes with an analysis of the forces in simple suspension cables and the determination of the length of the cables under the loads. This first chapter illustrates the author's method of developing simple principles and applying them to a number of problems.

The way is now clear, in Chapter II., to develop the theory of combined stress in two and three dimensions, and to define shear stress; the Mohr circle is used to illustrate the stresses on the various planes in the body subjected to stresses on known planes. Chapter III. discusses torsion and torsional strains and stresses produced in shafts and springs of circular and other shapes. The stresses in, and elastic deflection of, beams of constant and variable sections as also bending in principal planes which are not planes of symmetry, are dealt with in a clear and satisfactory manner. The more difficult problem of bending when Hooke's Law is not obeyed and the bending of beams made of materials having different moduli in tension and compression, is then discussed. Direct and bending stresses and combined bending and twisting are dealt with in two chapters, followed by an instructive and illuminating chapter on strain energy.

A careful study of this volume will give to a serious student a good knowledge of the elements of the subject and prepare him for the second volume, which, except for the last two chapters, which deal with the mechanical properties of materials, including the effect of repeated stresses and of high-temperature metals, applies the principles discussed in the first volume to complicated problems of practical importance. Beams supported on elastic foundations, long struts with lateral loads, the bending of curved bars, the buckling of thin plates, deformations and stresses in rotating discs, stress concentration and other problems, are discussed.

In order not to introduce mathematics beyond that point which may be reached in an engineering course, the solutions of certain problems are stated and not proved, references being given in these cases to original sources.

The work should be of real assistance to advanced and research students and to designers dealing with special problems and should find a place in every engineering college library. It is clearly written, the illustrations are satisfactory, and the reference to original papers will be of great assistance to those prosecuting research.

BOOKS RECEIVED.

Engineering Mechanics. By F. L. Brown. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 20s. net.

Practical Cost Accounts. By Andrew Miller. London: Gee and Co. (Publishers), Ltd., 8, Kirby-street, E.C. 1. Price 8s. 6d. net.

Electric Welding in the Construction of Sea-going Vessels. By G. Wahl. Glasgow: The Institution of Engineers and Shipbuilders in Scotland, Elmbank-crescent. Price 7s. 6d. net.

Wellington (New Zealand) Harbour Board, Statement of Accounts, with Annual Report and other Statistics, for the Period Ended September 30th, 1930. Wellington: Published by the Board.

Elementary Hyperbolics for Technical and Other Students. Two volumes. By M. E. J. Gheury de Bray. London: Crosby Lockwood and Son, Ltd., 7, Stationer's Hall-court, E.C. 4. Price 7s. 6d. per volume.

Applied Mathematics for Engineers. Vol. III., Differential Equations with Applications. By T. Hodgson, B.A., B.Sc. London: Chapman and Hall, Ltd., 11, Henrietta-street, W.C. 2. Price 13s. 6d. net.

The Revised Heat Drop Tables (1931). Calculated by H. Moss, D.Sc., &c., from the new data and formulæ of the late Professor H. L. Callendar, C.B.E., M.A., &c. London: Edward Arnold and Co., 41, Maddox-street, W. 1. Price 12s. 6d. net.

Kelly's Directory of Merchants, Manufacturers and Shippers of the World. Vol. I., Foreign Countries; Vol. II., Great Britain, India, and the British Dominions, Colonies, Protectorates and Dependencies. London: Kelly's Directories, Ltd., 186, Strand, W.C. 2. Price 64s. net.

The Water Gas Process: A Study of the Carbon and Thermal Balances. Fuel Research Technical Paper No. 30. By J. G. King, Ph.D., &c., and B. H. Williams, Ph.D., B.Sc. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 9d. net.

SIXTY YEARS AGO.

FOR six years preceding 1871 a Royal Commission had been inquiring into the pollution of rivers. It had issued report after report, but Parliament was faint-hearted on the subject and the rivers remained as noisome as ever. Such was the apathy of the Government towards the subject that in spite of the Commission's report and the protests of the Thames Conservators, the House of Commons had no hesitation in granting Richmond the privilege of discharging its sewage into the river for a further period of three years. The latest report of the Commissioners was discussed in our issue of June 9th, 1871. It dealt chiefly with the rivers Aire and Calder. From Skipton to its junction with the Calder, 10 miles below Leeds, the Aire was polluted by the refuse from 1341 cloth and woollen factories, a silk mill, a flax mill, seven paper mills, twenty-six tanneries, thirteen chemical works, eight grease extracting works and four glue factories, and, in addition, received the sewage from a population of more than a quarter of a million people. At Keighley, the bed of the tributary river Worth had been raised 5ft. or 6ft. in the space of forty years by the rubbish and ashes thrown into it. Where trout had once been plentiful nothing living except rats existed. At the Aire and Calder corn mill the water and the foam upon it were alike black and the miller and his men suffered continuously from nausea. The condition of the river Calder was no better. At Todmorden the river bed had been raised by refuse to such an extent that the town suffered severely from floods. Halifax, Huddersfield, Batley, Dewsbury and Wakefield added their quotas of refuse and filth. The gaseous emanations from the water turned paper yellow and caused loss to the paper mills. The Commissioners actually reproduced in their report a memorandum written by Mr. Charles Clay, an agricultural implement maker, with no ink except the water taken from the Calder near the outfall of Wakefield's town sewer. "Could the odour only accompany this sheet also," wrote Mr. Clay, "it would add much to the interest of this memorandum." Yet, at a point about a mile below the spot from which Mr. Clay derived his ink, the water supply of Wakefield was taken from the river. The Commissioners examined the condition of the river for themselves. They sailed up it in a steam yacht. The water, they found, was turbid and of a dark brown colour. An oily film floated on its surface and it emitted a mixed odour of sewage and gas tar. So far as the pollution of rivers by sewage as distinct from trade waste was concerned, we contended that a profitable remedy was ready to our hands. We believed strongly in the manurial value of native guano and the sewage irrigation of agricultural lands. The farmers, however, were stubbornly opposed to the idea and refused to co-operate with the companies formed to utilise sewage in that manner.

DUPLEX MILLING MACHINE

KEARNEY AND TRECKER CORPORATION, MILWAUKEE, ENGINEERS

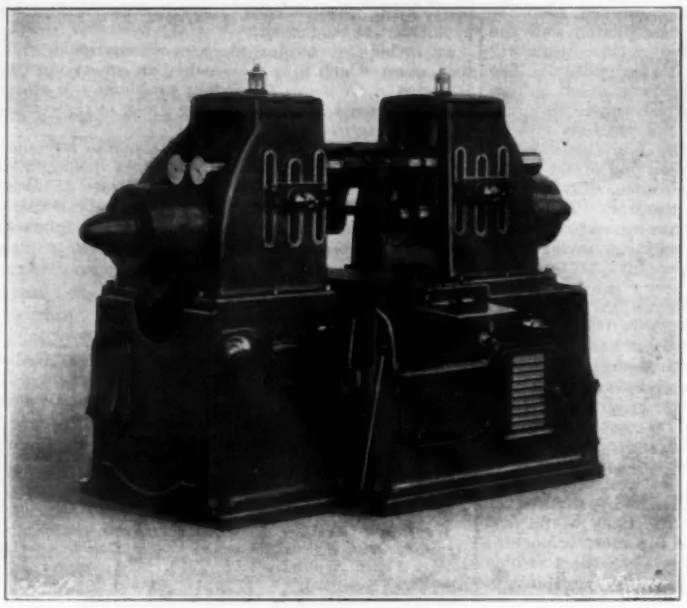


FIG. 1—FRONT VIEW

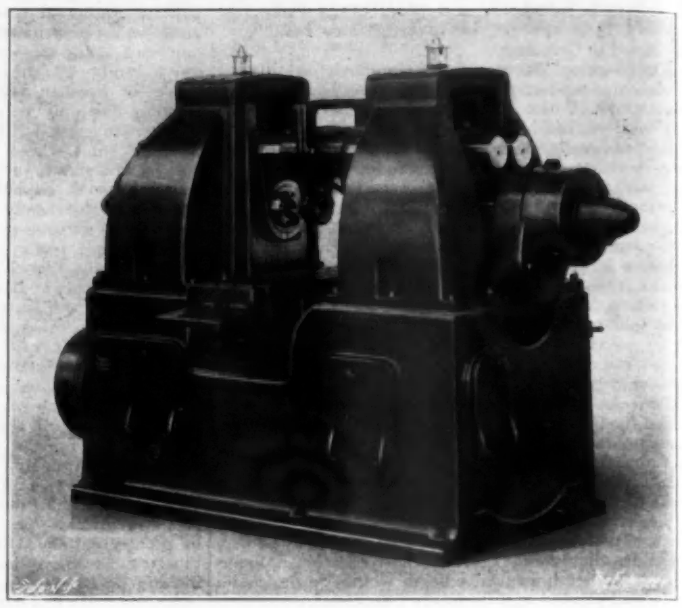


FIG. 2—REAR VIEW

Milling Machine for Tungsten Carbide Cutters.

A DUPLEX milling machine, with spindle speeds up to 1000 r.p.m. and table feeds up to 100in. per minute, has recently been produced by the Kearney and Trecker Corporation, Milwaukee. This machine, illustrated herewith, is constructed for the use of tungsten and tantalum carbide milling cutters.

Three speed ranges are available, namely, 15 to 150 r.p.m., 30 to 300 r.p.m., and 100 to 1000 r.p.m. Each range has twelve speed changes. The changes to each spindle are made independently so that cutters of different sizes can be used if desired. In addition, it is possible to provide one spindle with any one of the three speed ranges, and the opposite spindle with either of the other two. This feature permits the accommodation of work that requires the finishing of a small face on one side, and a much larger face on the opposite side. There is also a choice of three ranges of feeds, namely, $\frac{1}{2}$in. to 20in. per minute, 1in. to 40in. per minute, or $2\frac{1}{2}$in. to 100in. per

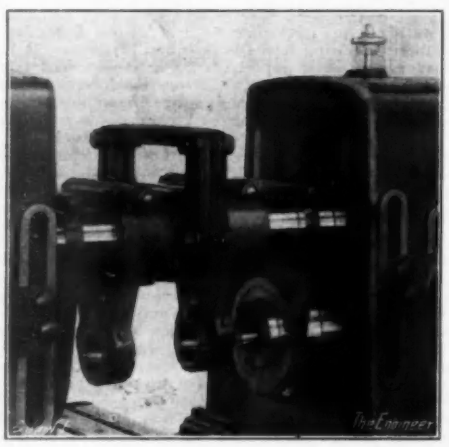


FIG. 3—SPINDLES ALIGNED

minute. Each range has eighteen individual feeds. The rapid power traverse for the table is 240in. per minute.

The machine is made in two sizes. The table for the smaller size is 12in. wide, and is furnished with longitudinal power feeds of either 18in., 24in., or 30in. The table for the larger size is 18in. wide, and can be equipped with a power feed of either 24in. or 30in.

Each spindle is mounted in a heavy forged quill, which is heat treated, hardened, and ground. These quills are 7in. in diameter and are provided with an independent cross adjustment of 7in. each. Movement of each quill is given by a hand crank attached at the front side of the uprights. Each quill is provided with a heavy brace that ties it directly to the overarms, so that the quill can be given a rigid support throughout its entire cross adjustment. The spindles are driven by hardened herringbone gears. The drive differs from usual practice, inasmuch as the large gear wheel is solidly attached to the spindle, and the driving pinion is splined to the pinion shaft. This feature insures a positive smooth drive to each spindle throughout the entire cross adjustment of the spindle quills.

The double overarms of each spindle unit can be laced together, as shown in Fig. 3, so that both spindles lie on the same plane. The brackets are, however, designed so that the overarms can be bolted together regardless of the vertical position of the spindles. If, for example, it is necessary to have one spindle higher than the other, the connection may be made, as shown in Fig. 4. This method

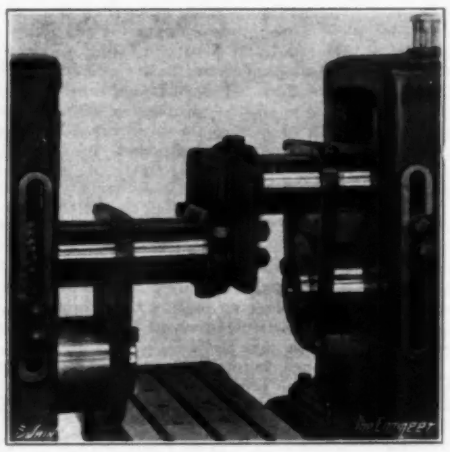


FIG. 4.—SPINDLES OUT OF ALIGNMENT

of tying together the overarms, spindle braces, and quills forms a rigid truss. The spindle units are mounted between two uprights and are aligned by bearing surfaces for their full length. They are guided by a deep tongued slide,

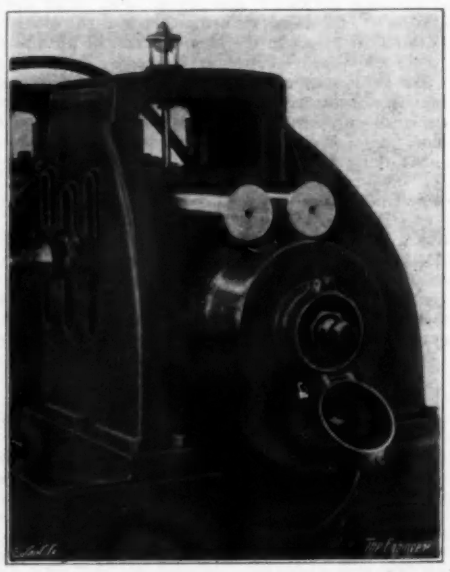


FIG. 5—FLY-WHEEL AND DRAW-BOLT COVER

and held in adjustment by a full-length gib. Vertical adjustment of the units is effected by a hand crank. This arrangement permits the spindle unit and spindle quills to be adjusted from a central point, since all the locking bolts and adjusting screws are situated close together.

A feature of the table design is the method of mounting the control dogs in a fully enclosed compartment. This compartment is accessible through a sliding door which can be withdrawn when adjustment of the dogs is required. By enclosing the dogs in this manner, chips cannot interfere with their operation.

The machine is automatically lubricated throughout by means of a geared type pump, which is driven from the main driving shaft. This pump is situated on the pulley side of the clutch, so that it is brought into operation as soon as the motor is started. A large geared type pump is used to distribute the coolant. The drive for this pump is situated on the opposite side of the clutch, so that it operates only when the spindle is rotated. The pump is made as a self-contained unit, and is driven by a sliding gear that can be disengaged by the operation of a small lever. When the machine is furnished with a coolant pump, troughs are attached at each end of the bed, and project slightly beyond the table when it is in its outmost position.

All rotating members of the machine, with the exception of the spindle noses, are fully enclosed, with a view to promoting safety. Fig. 5 illustrates the method of guarding the fly-wheel and the rear end of the arbor bolt. As shown, the hinged guard, which protects the draw-in bolt, can be lowered by releasing a thumb screw. The machine is equipped with a multiple V-belt drive, consisting of four belts. Adjustment of the belts to the proper tension is attained by means of a pivoted bracket on which the motor is mounted. The motor compartment is cooled by a circulation of air which is drawn inward by the fan type spokes of the main driving pulley. The machines are arranged to accommodate either a $7\frac{1}{2}$ H.P. or a 10 H.P. motor, running at 1750 r.p.m.

Research in Industry and Rationalisation.

ON Wednesday evening, May 27th, a dinner was given at the Swedish Chamber of Commerce, Trinity-square, E.C., by the Society of Swedish Engineers in Great Britain, in honour of Dr. Axel Enström, Director of the Swedish Academy of Engineering Research, Stockholm. The chair was taken by Mr. E. G. Sahlin, and amongst the guests were many notable Swedish, Danish, and British engineers. After dinner, Dr. Enström delivered the address which follows

RESEARCH.

Industrial development since the world war has to a large extent been characterised by claiming the assistance of scientific research to a much greater degree than ever before. Moreover, this period has attained a special impress of what has come to be called rationalisation, a term which really embraces a large number of movements of varying nature and import. It can with justice be maintained that research as well as rationalisation have become indispensable factors for economic working. They are frequently intimately connected, which I shall refer to later on.

"Research"—and "scientific research" above all—sounds so highbrow. We retain from days of old a conception of dry-as-dust and original individuals who practised "science" in a sphere high above practical life. That the results of science sooner or later could attain a significance as the foundation for practical applications we have, of course, always had in mind. But that science and research should come to be marshalled among the working tools of industry in daily use, as effective means for competition, did not indeed enter the imagination a generation ago, and perhaps even to-day it has not quite

penetrated the general consciousness, although it is an established fact.

A powerful impulse towards an intimate association between scientific research and industrial activity was given by the rise of the German chemical industry, which grew up on the foundations of the coke and gas industries during the latter half of the last century. These branches of industry were staffed by doctors of the universities, who in their day awakened not a little ridicule, especially in the Anglo-Saxon world. Another instance of an early and in an eminent degree scientific industry is the manufacture of optical instruments. In other respects science and industry, generally speaking, lived their lives as strangers to each other. But then came the world war, and with it the significance of science suddenly stepped into open daylight, when it became a question of procuring quickly all the new products which the situation demanded, both as regards the development of war material and the supply of substitutes for deficient raw material and the like. There are endless examples of these. The whole technique of wireless can be said to have been born in the trenches.

The history of the nitrogen industry is a speaking proof of the fruitful association of scientific and technical research with industrial activities and the reciprocal action of their factors, to touch on which at the present moment would, however, take up too much time.

The shortage of mineral oils gave the impulse to a scientific study of coal—of the essential composition of which nothing was previously known—with the object of determining the possibility of producing oils from the coal. These researches led to a new technique—pressure heating—the industrial sequel of which is not yet by any means exhausted. As is well known, oils can now be produced from coal without difficulty, besides other solid and liquid fuels.

The experience of the war period induced the countries involved as well as the neutral states to embark on research in the service of industry, especially when after the war the question arose of reorganising industry and putting it in the way of fulfilling the demands of peace and the new era following thereon.

In England an important initiative was taken by establishing the Department of Scientific and Industrial Research and the branch associations connected therewith.

In America during the last ten years enormous sums of money have been spent on institutions for scientific research by industrial undertakings as well as independently. According to the statement of a well-informed party, there were in 1926 about 1000 laboratories employing 15,000 men connected with the American industry, costing not less than 200 millions of dollars annually.

In Sweden we have with praiseworthy application accommodated ourselves to the demands of the new era. All the larger industrial undertakings have set up laboratories and engaged competent research staffs. According to an inquiry recently undertaken there are now in about fifty works research laboratories which employ some 600 people. The total cost of the industrial research work carried on in the country is probably in the neighbourhood of 4 to 5 million crowns—say, £280,000 to £300,000. Moreover, central institutes, such as the Engineering University and the Academy of Engineering Research, the State Testing Institute, &c.—carry out research work for the requirements of industry in cases where the works in question have not the special knowledge of the subject required for the problem in hand. Such knowledge, very diverse in nature specialised in many different directions is, in fact, demanded.

Now, what is it that characterises work as research and as scientific? Well, there are several points of view which play a part in this.

Generally speaking, we differentiate between pure science and technical or applied science. Both seek the truth. The former endeavours to increase knowledge without taking into consideration the nature of the result; the latter works with the object of attaining a given practical goal. Within each branch one can proceed in different ways. I should like to differentiate between spontaneous research and systematic research. The former is perhaps most usual in pure science, the latter in technical research. Röntgen, for example, was studying the passage of electricity through rarefied gases and then discovered that a screen in the neighbourhood of the apparatus was lighted up. He produced a shadow and the discovery of the rays which are named after him was an accomplished fact. That is what I call spontaneous research. H. Hertz, on the other hand, starting from the assumption that according to Maxwell's equations electric waves should exist in Nature, searched for and found them by means of systematic experiments.

In technical work it may happen that we cannot understand a phenomenon which occurs capriciously. We have perhaps no indication whatever of how to proceed. We then, for instance, set up a research apparatus in the laboratory and endeavour to vary the conditions for the process until we get some deviation which can be followed up. That is also spontaneous research, in which the capacity for observation plays a particularly important part.

In practical research work, however, it more often happens that we can determine by reasoning that the phenomenon must depend on such and such factors, and it then becomes a question of systematically following up the influence of each one of these variants and subsequently combining the different curves obtained and deducing from them, say, the optimum conditions for a procedure. As a typical instance I can cite an investigation, *inter alia*, carried out by the laboratories of the Academy of Engineering Research. It was a question of clearing up the possibilities for the production of cyanide. It could be anticipated that the process would depend on twelve different factors: pressure, temperature, gas concentration, &c. Each one of these was varied, whilst the others were kept constant, and as a final result the exact conditions for the technical structure of the process became apparent.

The tendency of modern research technology is to reproduce and study the technical procedure in the laboratory, on a limited scale. And as a rule it then becomes a question of reverting to the intrinsic process; that is to say, to the small particles, molecules, atoms and electrons. Previously—and still frequently, for that matter—the technical experiments were made direct and on a so-called technical scale. In America especially much of the progressive work has been based on such experimental activity. It may and can succeed, but is, at all events, very expensive. Often it is not successful because the natural laws which apply to the active small ingredients and their reactions may easily be obscured by incidental collateral circumstances associated with the technical plant. Enormous sums have indeed been wasted on such experimenting. We have in Sweden more than one instance of an undertaking which, after the outlay of tens of millions, has had to be abandoned. In one case, at least, which concerned a metallurgical process, subsequent investigations of a scientific nature, reverting to an intimate study of the interaction of ore particles and gases, brought daylight into the problem as a whole.

Modern technical scientific research demands of its practitioner a thorough knowledge of the fundamental physical and chemical sciences. Unfortunately, it is seldom that both of these groups of knowledge are represented to a sufficient degree in one and the same person, which is becoming more and more desirable. I have in mind a problem such as combustion, one of the most commonplace phenomena in fact. It has been attacked by steam experts, and it has been worked at by chemists, but as yet we know very little about the matter and as regards the shape which technical combustion devices should take we are still only groping. Here an intimate co-operation of physics and chemistry is required.

Another point which separates scientific research from the crude methods of earlier times is the methodical calculation and mathematical treatment, which at an early stage of the investigation may give valuable indications of the existing possibilities. It is now generally understood that it is not worth while to continue working at the problem of "perpetual motion," as it is contrary to a natural law. Frequently, however, this does not hinder the making of expensive experiments in other directions, following up objects which, may have been shown to be contrary to prevalent natural laws, in some respect.

Technical scientific research work should begin with a study of the literature, a collection of the knowledge which already exists in different quarters pertaining to the problem in question. A mathematical analysis should be undertaken in so far as it is possible. Then will follow the experimental investigation, if possible reverting to the intrinsic elementary process in conjunction with the fundamental laws of physics and chemistry. For this, scientific methods of investigation and instruments will be used, and it is therefore necessary that a thorough knowledge of these shall not be wanting. The best prospect of success will be presented if the research practitioner has at the same time an open mind for, and preferably practical experience of, technical matters, so that he will see the technical perspective of the scientific experiment. On the whole, it is, of course, necessary that he shall have good sound judgment, which is required, indeed, in every connection in this life.

I have now endeavoured to characterise what is involved under technical scientific research, such as is carried on in industry with the object of producing new products and methods, or for the improvement of manufacturing processes and the like. To this it should be added that in certain quarters much more is embraced in the term research, especially in America, where the control of manufacture and testing of materials are often relegated to the same conception.

Both these branches have, of course, points of contact with scientific research, at times slight, again more so, and sometimes in a high degree. It is certain that scientific working methods and instruments are becoming more and more necessary in all such work, demanding a correspondingly higher competence in the controlling *personnel*.

Before I leave this heading, I cannot refrain from saying a word in general regarding the much-talked-of quality of being scientific. The nucleus of this idea is in reality the capacity for clear thinking. A person who perchance is not in possession of all the knowledge of a natural scientific character referred to above may, nevertheless, with just claims to scientific working, solve technical problems of a less complicated nature—and many such crop up—if he will but apply logical thought to them. On the other hand, it must be admitted that there is a whole lot of quasi scientific matter. There are people who collect knowledge in the same way that one collects stamps, who habitually make use of the coded terms of the various branches of science, but who lack the capacity for the co-ordination of thought. Such augurers are unfortunately not rare, and they do harm by awakening distrust of the word science in the mind of the practical man of industry, and cause him to overlook the invaluable services which well-qualified technical scientific research is capable of rendering.

In intimate connection with research in modern times is the development of inventions. A successful inventive activity is now, in fact, hardly possible without association with more or less highly qualified scientific investigation, in combination with the more complicated system which is characteristic of all that to-day constitutes the permanent condition of things—that is to say, the platform from which the leap towards the future must be attempted. This could be demonstrated by many examples.

RATIONALISATION.

By rationalisation we mean measures which aim at increasing, improving, or cheapening production. In good times the increase in production is of preponderant interest, whereas in bad times a reduction in cost is of the first importance.

The term rationalisation embraces measures of many descriptions. The efforts to economise labour and energy, taking a study of the times and an increased use of machinery as the jumping-off point, may probably be taken as the central measure. As a general result of the development of recent years, an increased mechanisation of work has been evident, not only in the works, but also in the office and the sales and distributing departments. Rationalisation also embraces measures of a financial nature aiming at the economy of capital. Endeavours to save in the matters of capital and management lead to amalgamation and trust building—that is to say, to the creation of great economic units.

In these days of widespread unemployment, the question has naturally been thrust into discussion as to whether a continued increase in the use of machinery, involving the discharge of superfluous hand labour, is justifiable. It is probably too soon yet to expect a definite answer to this question. Reasons and counter-reasons are advanced which for the time being shatter themselves against each other. For my part, I cannot do otherwise than think that rationalisation must progress with natural necessity. Economic history shows that development goes steadily in the direction of the direct exchange and relief of human labour by the introduction of tools. But we have no general view of the correct proportion between direct production for consumption and production of machinery and tools. Occasionally, it happens that the latter outstrips the former a little. Then a crisis, such as the present and many previous ones, occurs. But experience shows also that the crisis subsides in a couple of years. Equilibrium is established and the tools produced earlier gradually come into full use. There is no reason to despair of the present depression being relieved in the same way by continued development bringing with it a new line of equilibrium between directly applied labour and indirect such—that is to say, tools and machines.

Even if the transition period be difficult and full of suffering for many people, economic history, nevertheless, furnishes good grounds for taking an optimistic view of development in general.

Standardising constitutes an important branch of rationalisation. This has proved to be an effective medium in cheapening production. Standardising aims at the utmost economy in material. As soon as one enters the domain of materials, scientific research must often be called in to assist in carrying out the necessary investigations, whether it concerns standardising purposes or other efforts at rationalisation in industrial undertakings. This is, however, not the only point of contact. Very frequently it happens that some research work which had its origin in a manufacturing problem—for instance, the remedying of a defect in quality—has been found to result likewise in a rationalising effect in so far as it, on the whole, led to a definite result. I could cite masses of examples of the significance of research in this respect, but shall confine myself to some few only taken from our experience at the institute which I represent—the Academy of Engineering Research.

A request was made for an investigation of the conditions for the correct annealing of a certain metal manufacture. It was a question of mass production of small parts. The investigation resulted not only in information concerning the right temperature and time conditions for the annealing, but also gave occasion for the transition from a large and expensive fuel oven to a small continuous electric oven which, in its turn, involved the whole manipulating plant in the so-called "continuous band process." By this a considerable economy in labour and space was effected.

Another case concerned the finding out of the reason for a capriciously occurring defect in some grinding wheels. The cause was discovered, but at the same time the analysis of the phenomenon gave occasion for another and rationalised manufacture, thus involving not only an improvement in quality but increased economy in production.

The industry of a small country, if it is to have any prospect of competing in the world's markets, must endeavour to concentrate on products of high quality. Swedish industry has had to do so. Without being considered as lapsing into boastfulness, I may venture to contend that various Swedish industries have succeeded during the post-war period in attaining a footing on the world's markets, in spite of difficulties which many times appeared to be hopeless. The progress of an industry depends, indeed, as a rule, upon many co-operating factors—skill in the financial management, pre-eminent organisation, ingenious experts and competent workers. But if I take a look at the chief Swedish industrial undertakings, I can testify that a powerfully contributive share in the progress is due to purposeful incorporation of scientific research, well-equipped laboratories, and a highly qualified staff with the industrial activity. With the assistance of these, it has been possible to keep the quality at the summit, to follow the rapidly changing demands of the times for new products, and also to be able to continue improving and cheapening the manufacturing processes. I could, in virtue of experience, cite specific examples of what I have said, but it would carry us too deep into details.

Among manufacturers of the old school it was usual to rely on experience, and—as it was so beautifully expressed—sound common sense. This is no longer sufficient. Previously, the old foreman with his empirics often took higher rank than the scientifically educated engineer. Development has completely reversed this classification. Many have paid dearly for not keeping pace with the times, but held fast to the old traditions, which have degenerated to a jog-trot.

A wideawake criticism to begin with is of much value. I cannot refrain from telling a little story about rationalisation in this connection. A friend of mind who at the time was technical chief in a large cellulose concern, was one day disturbed at a highly critical moment by his engineer who reported that the bottom valve of a digester had broken, and that a new 3in. valve must be procured at once. Without actually knowing why, my friend asked, "Why just a 3in.? Why not a 4in. valve?" "It has always been usual to have 3in. valves," was the reply. "Then we must find out which is the most advantageous, 3in., 4in. or 5in." A hasty survey of the situation showed that a 5in. valve could not be attached, but a 4in. could, and this would shorten the time taken to empty a digester by so much that the annual production could be increased by 20 per cent., which, when put into effect throughout the mill, meant an increase of millions in the yearly profits. An instance of the old saying—"Small causes, great effects."

The new era demands constant vigilance, and in industrial management a sound intelligence, coupled with a capacity for critical analysis, supplemented by and intimately associated with scientific knowledge, and the power for, and the habit of, experimental penetration to the very essence of things and phenomena. In industrial activity one must either possess technical scientific competence and procure the necessary laboratory resources, or in cases where this is not economically justifiable, independent research institutes should be consulted.

Over-Voltage Problems.

By Dipl.-Ing. A. H. VON ALTMANN.

ALTHOUGH considerable progress has been made in the direction of combating the detrimental effects of all kinds of over-voltage, perfect protection for overhead lines and apparatus has not been attained. Improved oscillographs and over-voltage indicators, such as the Klydongraph surge recorder, have, however, greatly facilitated research and many effective pieces of apparatus have been introduced. Over-voltages on networks and apparatus may be caused (1) by atmospheric disturbances, which are probably the most dangerous and difficult to combat; (2) by switching operations, either under normal service conditions or fault conditions, but in the majority of these cases these over-voltages do not result in damage, and (3) voltage increments produced by intermittent earths. If the plant is liberally insulated, these effects may also prove harmless, but may lead to excessive disturbances.

The best method of categorising over-voltage phenomena is to consider characteristics rather than the cause. Over-voltage phenomena may be divided into three groups—steady, quasi-steady and unsteady. The first are known as static charges on the lines, as produced by thunderstorms, and may produce flash-over or puncture, resulting in unsteady equalising effects. Troubles with these over-voltages may, however, be said to have been overcome by means of lightning arresters. Over-voltages produced by mutual influences may also be included in this category, but, usually, they are not dangerous on lines designed for high working voltage. Quasi-steady processes may be traced to various causes, such as all kinds of arcing, disconnection of sections of the line, intermittent earths, resonance phenomena caused by single-pole switching, the breakage of a conductor or a short circuit and the voltage arising on rupturing circuits composed mainly of inductance. The

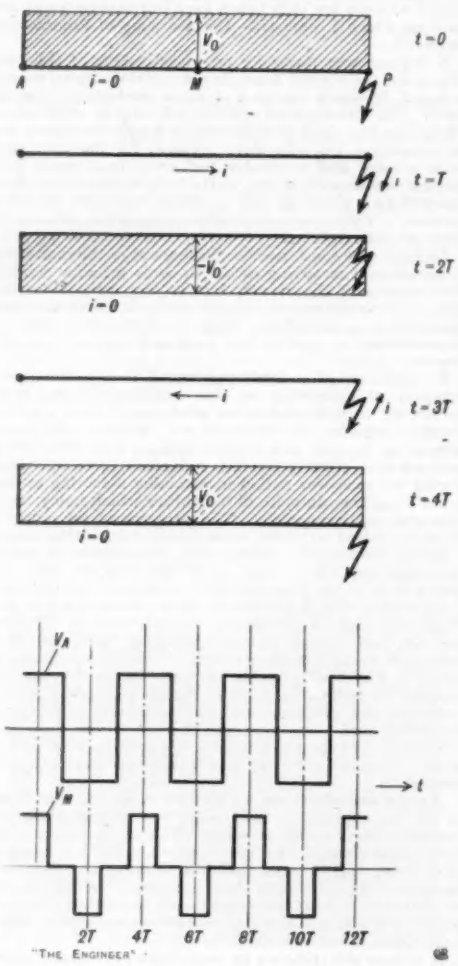


FIG. 1—TRAVELLING WAVE OSCILLATION

recommendations for the protection of electrical plant against over-voltages, issued by the German Institute of Electrical Engineers, contain much data in this connection.

Unsteady processes are usually provoked by atmospheric discharges and intentional or accidental switching operations, and the waves travel along the line with a velocity approaching that of light. Owing to their steep fronts these waves are extremely dangerous. If an earth or short circuit occurs at a point P—Fig. 1—of a line which is uniformly charged at a potential Vo, the voltage at this point will be zero. The disturbance spreads from the point P in a manner analogous to water in a main on which a stopcock has been suddenly opened, and the electrical charge flows away until the discharge wave reaches a point A and the entire line becomes dead. On account of the magnetic field produced by the flow of current, the latter will not cease immediately, but will cause the entire line to be charged up to a potential Vo in the time $t=T$ to $t=2\,T$. A charging current which again builds up the line potential now flows into the line until, after a lapse of time $t=4\,T$, the entire system again assumes its initial condition. When applying theoretical hypotheses of this nature for judging the oscillograms of transients it must, of course, be remembered that, in practice, it is not always possible to determine the true rectangular forms of the voltage curves, owing to the ohmic losses and the capacitance of the insulators.

These switching surges or travelling waves may possess extraordinarily steep fronts, and researches in Germany with the cathode ray oscillograph have shown that voltage increments in the neighbourhood of 10 kV per metre can occur, and that a wave front of that nature can still retain the same form even after considerable propagation. Observations on the transmission lines of the Swiss Federal Railways revealed voltage increments of about ½ kV per metre in the presence of direct lightning strokes, or strokes in the immediate vicinity of the lines. The duration of the voltage impact fluctuated between 20 and 40 microseconds, equivalent to a travelling wave length of 6 kilom. to 12 kilom. American measurements have indicated voltages up to about 1·3 million volts on a 100 kV line. The front of the wave amounted to 300 m. over a distance of 30 kilom. Allowing for the fact that only a small percentage of the lightning energy existing at the point struck propagates along the line, the length of a travelling wave produced by a direct stroke can be calculated at about 100 kilom. The maximum lightning current amounts to 175,000 ampères, the time constant of the lightning discharge until the current intensity drops to 50 per cent. of the maximum value being about 26 micro-seconds.

It is now proposed to consider whether the voltage which emanates at the point struck by the lightning or the point or in the immediate vicinity of the lightning, and which is about 12–15 times the peak value of the normal line voltage to earth, will remain at its full value when travelling along the line. The maximum voltage of the lightning is diminished by the ohmic resistance, by leakage and particularly by corona, the latter also reducing, among other things, the steepness of the wave. Practical measurements have resulted in the following empirical formula:—

$$e=\frac{e_0}{KLe_0+1}$$

where e_0 is the voltage at the point of origin of the over-voltage in kV, e the voltage, 1 kilom. from the point of origin, and K a factor between $1\cdot10^{-4}$ and $6\cdot10^{-4}$. From this formula it is evident that the over-voltage at a considerable distance from its point of origin is considerably reduced. Further investigation will determine whether this formula covers all conceivable cases with sufficient accuracy. In any case, the results of the Swiss investigations are particularly striking. According to these investigations, the magnitude of the voltage increment is generally greater than that of subsequent voltage collapse produced by a line short circuit—possibly introduced by flash-over—this being a direct contradiction to the results obtained in Germany and America. The magnitude of the lightning voltage may be deduced from available American measurements made with the aid of a large number of Klydonographs distributed over a 132 kV line, whereby a voltage peak of 2100 kV, corresponding to about 1500 kV effective, was obtained with subsequent short circuit, whilst pressures of 1450 and 1000 kV were observed without subsequent short circuit.

Involuntary switching operations can also produce an extraordinary abrupt voltage gradient, and in the case of transformers they may prove more dangerous than voluntary switching operations, the danger being intensified when the point of flash-over is near the windings. Owing to the collapse of the voltage, the stresses on the windings can re-occur many times in rapid succession, and result in winding defects, whereas a single stress might not inflict any damage. If the part of the system capable of oscillation be a line with distributed inductances and capacitance, the result will be a transient oscillation, but concentrated inductances and capacitances often have to be considered, and these readily cause "stationary oscillations," the wave crests of which occur at certain parts of the plant, which need not be the weakest parts.

A summary of the foregoing considerations leads to the following conclusions:—(*a*) Deleterious voltages may be directly provoked by steady, quasi-steady, and unsteady processes, and as a rule they endanger the weakest part of the system. In so far as they are produced by "stationary oscillations," they only occur at limited sections of the plant, and are merely a source of danger to parts within the vicinity of the voltage peaks. (*b*) Abrupt voltage gradients only occur directly in the presence of unsteady processes, but they can also be caused by steady or quasi-steady processes. Usually, effects which are brought about by lightning over-voltages, and produced by direct or secondary lightning strokes, are by far the most dangerous, but only a small proportion of all lightning strokes prove a danger to the system. (*c*) There are two methods of neutralising the effects of over-voltage phenomena. In one case the line insulation may be reinforced so as to avoid short circuits and earths, and the transients must be rendered harmless by protective devices before they can have an adverse effect on the station equipment. The other method is to allow flash-overs to occur even at moderate voltages. Both methods are adopted in practice, the first being used chiefly in America and the second in Europe. The first method has the merit that the impulse voltage value of the insulators is about double the flash-over value at normal frequency. The insertion of valve type arresters on every insulator string has frequently been recommended, but, apart from the expense, the scheme presents other difficulties. A maximum leakage current of 10 ampères at normal voltage requires a resistance of 10,000 ohms for a 100-kV line. The impulse voltage valve of the insulators amounts to about 1,000,000 volts, and, as Fig. 2 shows, gives an admissible arrester leakage resistance of about 15 ohms. This requires that the current consumption of the resistance material increases at least as the 3·7 power of the voltage, whereas values higher than 3·5 have not been attained with the most effective arresters known.

Another scheme is to keep the direct lightning stroke from the line by providing overhead guard wires and lightning rods. As the lightning current flows over several towers in the vicinity and so reduces the difference in potential between conductor and earth wire due to mutual induction, the voltage or resistance values specified in Fig. 2 must be multiplied by 0·79, to ascertain the maximum voltage between earth wire and conductor. Assuming that under highly unfavourable conditions the normal lightning current of 175,000 ampères be exceeded by 3·5 times the admissible earth resistance of a tower would be 5 ohms maximum, with a 200-kV line and 2 ohms maximum at 100 kV, and these values should be obtainable economically if the ground conditions are not too poor. The second method is based on the fact and substantiated by numerous measurements and observations that, even when the insulation is reinforced to an uneconomic degree, a line flash-over cannot be prevented with certainty, and that the most dangerous over-voltages are confined locally, both longitudinally and transversely, to the line. In general, a lightning stroke only destroys one conductor, and, if the tower is efficiently earthed, leaves the other undamaged.

One of the most important protective devices used at present on European lines is the surge-proof insulator, which is not destroyed when a surge occurs, the puncture voltage being kept much higher than the flash-over voltage. In networks with earthed neutrals the insulators should be able to withstand the short-circuit current subsequently flowing, whilst on networks with insulated neutrals they should not only be able to cope with the earth current, but also short-circuit current. The insulators must be of arc-proof design, and there are other requirements, such as small tower earthing resistance and large distance between phases. The insulators should also be free from retardation; in other words, their flash-over value should be independent of the voltage increment expressed as a function of time. It is often found that a tower of low height has a favourable effect, owing to the increased earth capacitance, as obtained, for example, by the A.E.G. swinging bracket type of tower.

As shown, over-voltages are greatly damped during their propagation along the line, and lightning over-voltages are only dangerous in the neighbourhood of the station. The voltage waves entering the station or their reflection effects can be neutralised in various ways. The insulation of the station can be given a value higher than that of the overhead line, but this method is not recommended by the A.E.G. The retardation of the station insulators to flash-over can be artificially increased or special protective apparatus can be installed. A single-pole line flash-over must also be rendered harmless, and the Petersen arcing ground suppressor described in THE ENGINEER of August 1st, 1930, has proved highly successful for networks with insulated neutrals. With a solidly-

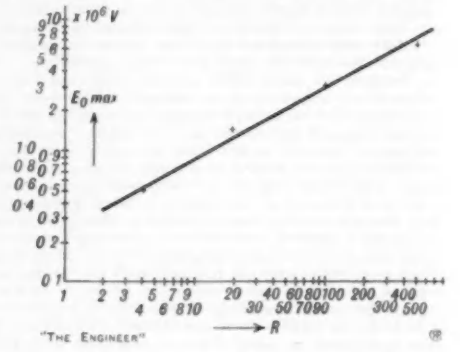


FIG. 2—RELATION BETWEEN OVER-VOLTAGE AND ARRESTER RESISTANCE

earthed neutral every earth represents a short circuit, and a selective relay must be used to disconnect the faulty phase. In many cases the healthy phases will prevent stations working in parallel from falling out of step.

Before discussing over-voltage protective devices, it is proposed to enumerate the services generally expected of them. (*a*) The first requirement is the reduction of pressure so that voltages exceeding a certain value cannot enter the station. The protective apparatus must therefore begin to operate at a certain voltage below the flash-over value of the station equipment, and reduce impinging waves to an admissible value, independent of their magnitude and characteristic. With resistance varying as a function of the voltage, the current consumption must increase much more rapidly than as the square of the voltage, viz, the resistance must drop at a rate more than inversely proportional to the voltage. (*b*) The protective effect must take place as free from retardation as possible, for otherwise a wave of smaller or larger length and of full amplitude will enter the station. Although it can be assumed that very short voltage peaks, even of considerable magnitude, are not detrimental, there is at present an entire absence of numerical data to justify the omission of the above requirements. With protective apparatus with voltage ampère characteristics, the alteration of the resistance must not lag behind the voltage. (*c*) The functioning and limiting voltage should differ but little from each other, so that the protective apparatus does not commence to operate under normal service conditions and so that the transients entering the station have no adverse influence after having been reflected. A value of about 2 E, where E is the effective line voltage, may be considered to be admissible for the operating and limiting voltage, since the test voltages are generally higher. (*d*) The steepness of the front of the waves entering the station must be reduced to a harmless value, as main transformers, potential transformers, and possibly current transformers are particularly endangered. Those who maintain that transformer windings are not dangerously stressed by over-voltages assume that the impinging transients travel along the individual turns, but it is much more probable that this longitudinal voltage distribution does not occur, but that the entering wave travels transversely over the individual capacitances. It may also happen that the entering wave is itself harmless, but can give rise to oscillation which may produce dangerous voltage increments.

Although transformers are endangered by transients, it is now possible to build them in such a manner that to a large extent they are proof against such phenomena. In this connection it may also be mentioned that the liability of oscillation is greatly augmented by increasing the ratio of transformation, and transformers with too large a ratio

are best avoided. (*b*) The operation of the protective apparatus must be reversible and must possess the same voltage characteristic for voltage increments and decrements, a requirement that is of particular importance when the resistance of arresters is dependent on voltage—*i.e.*, arresters with volt-ampère characteristics. Condensers can be used to increase the earth capacitance of a system and thus to reduce static charges, and also to shift the point of resonance, but in these days they are seldom employed. When used as a protection against transients they have the merit of following a sudden alteration in voltage very sluggishly, and therefore have a decided flattening effect upon the wave front. The ideal requirement that the condenser voltage should follow the transient voltage of the line perfectly, cannot be met in practice, for, owing to the connections between line condenser and earth, the protective effect of the condenser is impaired. The surge impedance of the connections should differ from that of the line, and preferably it should be less than that of the line. If this requirement is met, then, according to modern theory, even the sharpest points in the connections have no detrimental effects.

When resistances are connected in series with protective condensers to ensure an appreciable dissipation of energy, they should have a value approximately as great as the line surge impedance, so as to avoid reflection of the voltage wave at the open end of the line. The flattening effect of the condenser under these conditions is practically lost, but if the resistance is comparatively small the energy dissipation will also be small. Condensers with resistance will only prevent oscillations—which may cause resonance—with any degree of certainty if they themselves form a considerable part of the oscillatory circuit. A certain amount of protection can be provided against travelling waves by condensers, and an important factor for combating travelling waves is that the full capacitance of the condenser should be effective in periods of 10^{-6} seconds and less.

In some respects the conditions with choke coils are similar to those with condensers, the chief purpose of the choke coil being to prevent abrupt voltage gradients. Research work with the cathode ray oscillograph has shown that the effect of distributed inductance in a coil does not differ greatly from that of a concentrated inductance, and that turn capacitance has no very pronounced adverse influence upon the operation of the coil. Conditions differ as regards the earth capacity, and an increase in such capacity adversely affects the protective action of the coil. All designs should be condemned that have a large distributed earth capacity if the surge impedance of the protective arrangement is small in comparison with that of the line.

Bridging resistances should not have a pronounced volt-ampère characteristic. Coils with iron are totally unsuitable for over-voltage protection on account of the iron inertia. Condensers and choke coils differ widely as regards their influence upon the section of the line before and behind the protective equipment. With condensers the initial steepness merely depends upon the surge impedance of the line along which the wave travels. The apparatus to be protected and the outgoing lines have no effect. With choke coils, on the other hand, the surge impedance of the equipment to be protected exercises a considerable influence. Conversely, the surge impedance of the incoming line only appears as a ratio to that of the unprotected outgoing lines. The connecting in series of choke coils and condensers or intermediate cables gives satisfactory results. It can be shown mathematically that the initial steepness of the altered rectangular wave diminishes to half with open-ended lines, and under favourable conditions the maximum voltage is reduced by the same amount. When the natural frequency of a circuit comprising choke coils and a certain capacitance of the end turns of the transformers protected agrees with the frequency of the discharge wave of the connection between the earth fault and transformer, voltage increments of more than double that prevailing before the choke coil occur. The danger can be overcome, however, by suitably dimensioned bridging resistances with a maximum ohmic value of $R=\frac{1}{2}\sqrt{\frac{L}{C}}$, L being the coil inductance and C the entrance capacitance of the transformer. This principle is adopted by the A.E.G. with protective choke coils of the Campos protective system, but choke coils with an inductance with less than 4–5 m.H. are useless and are occasionally a source of disturbance; in fact, modern practice does not favour the use of choke coils for over-voltage protection.

Cable sections in overhead lines mitigate abrupt potential gradients. When a surge impinges on the comparatively small surge impedance of the cable the wave voltage will first collapse and then rise again in steps, the magnitude of these steps being determined by the relation between the surge impedance of the overhead line and of the cable, whereas the breadth is determined by the length of the cable. As the surge impedance can scarcely be varied, the protective effect depends in practice upon the length of the cable used. Calculation shows that the requisite protection is only attained with cable lengths of about 100 m. and the employment of cable in the usual lengths of 10 m. to 50 m. gives a smaller protective effect than that provided by condensers.

Turning now to arresters with damping resistances, attention will first be paid to constant-resistance arresters which do not flatten the wave front or change the wave form, the action being restricted to voltage reduction, which in high-tension lines has at least the same importance as flattening of the steep wave front. In consequence of the characteristic of a spark gap the voltage in the gap is rapidly augmented until an arc is produced, whereupon the voltage drops rather abruptly. The spark gap undoubtedly has sluggish properties, but it will permit an over-voltage wave of very short duration to enter the station. In many cases, however, this circumstance is not detrimental, as the insulators and insulating materials used have at least the same retarding characteristics, and quite short-voltage surges, even of high amplitude, appear to inflict little or no damage. Nevertheless, it is advisable to keep the connections as short as possible.

The dimensioning of damping resistances presents difficulties. A few thousand ohms may be regarded to be the correct value for voltage increments provoked by quasi steady processes. Voltage jumps or oscillations then present no danger, and only the interruption of the arrester current can cause difficulties at high voltages. For unsteady processes the resistance values should be smaller than the impedance of the overhead line; hence at high voltages very large leakage currents occur and well-known difficulties are experienced. A spark arrester cannot be expected to afford simultaneous protection against the consequences of quasi-steady and unsteady processes. The opinion that, having regard to the maximum dissipation of energy, the value of the resistance should be exactly equal to the surge impedance is erroneous because voltage reduction is of greater importance than energy dissipation.

A large reduction in voltage is particularly desirable when the insulation of the line is strong in comparison with that of the station. Complete dissipation is only possible with open-ended lines, and, from a theoretical point of view, the energy which can be dissipated decreases in inverse proportion to the number of outgoing lines. In cases in which the insulation of the station is better than that of the line, it is advisable to omit arresters with permanent resistances in switching stations, especially

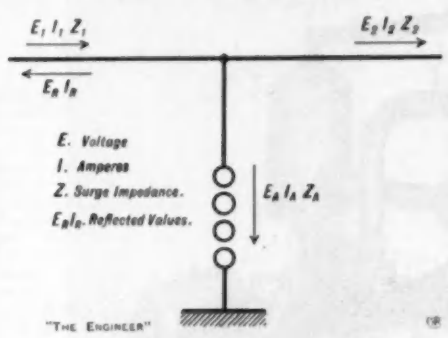


FIG. 3—CHARACTERISTIC VALUES OF ARRESTER IN SWITCHING STATION

as absolute freedom from disturbances can scarcely be obtained with this kind of over-voltage protection. Resistances which vary in inverse proportion to the voltage remove many of the difficulties inseparable from permanent resistances.

The chief characteristic of the valve type arrester is that it dispenses with a current-limiting resistance. Functioning and limiting voltages should be selected twice the line working voltage. The relation between resistance and voltage should at least be selected according to the equation $R=\frac{Z}{M-2}$, or, better still, $\frac{Z}{M^{1.5}-2}$ where Z denotes the surge impedance of the overhead line, on the average 500 ohms, and $M=\frac{e_1}{E}$, where e_1 is the voltage of the modified wave and E the working voltage. If an arrester has to possess a constant limiting voltage e_{r2}, its resistance is calculated, as a function of the magnitude of the propagating wave e_{r1}, as $R=\frac{e_{r2}\cdot Z}{2\,(e_{r1}-e_{r2})}$. Assuming e_{r2} equal to 2 E, we obtain the aforementioned formula. If the limiting voltage is selected higher, there is the danger that the station equipment will be damaged, while, if

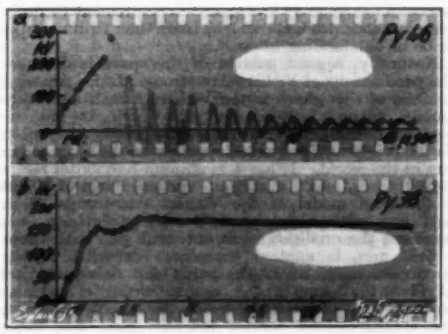


FIG. 4—BUS-BAR FLASH-OVER OSCILLOGRAMS AT 380 KV.

it is selected lower, the potential of the wave increases, for the waves are reflected at full amplitude when the arrester resistance is zero. As already mentioned, functioning, limiting and arc extinguishing voltages should, if possible, be of the same value and be independent of the kind, magnitude and duration of the over-voltage phenomena. Frequently the high functioning voltage is due to retarded operation of the arrester; but this difficulty can be overcome by connecting a suitable condenser in parallel, so as to flatten the entering wave.

A brief description will now be given of two typical valve arresters, *i.e.*, the Thyrite arrester of the General Electric Company of America and the S A W arrester with voltage-ampère characteristic of the A.E.G. Applying the symbols of Fig. 3, it will be found that

$$E_A=\frac{2\,E_1-Z_1\,I_A}{1+\frac{Z_1}{Z_2}}$$

This equation shows that for given values of Z_1, Z_2 and E_1, the determining voltage E_A largely depends upon the magnitude of the arrester current I_A. The curves of the Thyrite arrester* indicate that the dependency of the arrester current upon the voltage is very great. With the Thyrite arrester the current increases and decreases as the 3·5 power of the voltage and the resistance as the 2·5 power. The relation is maintained practically constant over the entire range of application.

American engineers have also realised the advantage of combining valve type arresters and paralleled condensers. The equation corresponding with such conditions is

$$Z_1\,C\,\frac{d\,E_A}{d\,t}+\left(1+\frac{Z_1}{Z_2}\right)E_A+Z_1\,I_A=2\,E_1$$

This relation can be derived without difficulty from the well-known formula for a condenser, viz.,

$$Z_1\,C\,\frac{d\,E_C}{d\,t}+\left(1+\frac{Z_1}{Z_2}\right)E_C=2\,E_1$$

Experience with the Thyrite arresters has shown that the working characteristics meet all expectations. The development of the S A W arrester was attended by the difficulty experienced with the pure resistance arrester, namely, that of providing an adequate heat capacity. Attempts have been made to extend the heating capacity in two ways; first, by shortening the period during which the subsequent working current stresses the arrester, and secondly, by reducing the current consumption of the arrester by inserting resistance directly after it has began to operate. A significant advance was made by combining these two expedients, as in the voltage-dependent resistance arrester with a multi-spark-gap. The extinguishing spark-gap reduces the duration of operating to less than half-a-cycle, and the resistance, which is largely dependent upon the voltage, automatically ensures that on the reappearance of the working voltage the resistance is much higher than the effective resistance during the over-voltage period. The immediate return to the condition for operating again is ensured. Moreover, the S A W arrester is completely free from hysteresis. The characteristic of the ideal arrester, viz., the aluminium cell, which, from the outset, operates as an effective condenser, may be achieved by connecting a condenser in parallel. Another advantage of the S A W arrester is that the

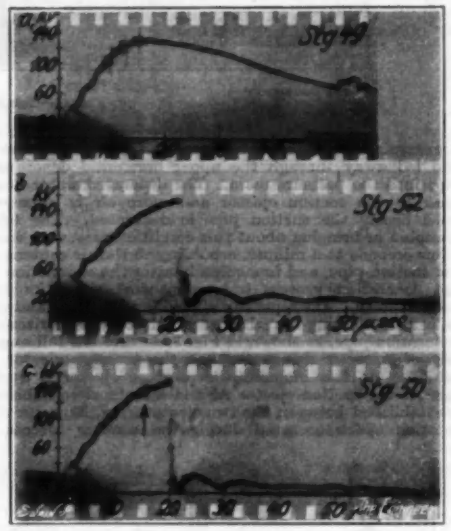


FIG. 5—BUS-BAR FLASH-OVER OSCILLOGRAMS

adjusted voltage does not increase, as with some types of valve arresters, and there is a fair amount of flexibility in the adjustment of the functioning voltage.

In Germany, tests with impulse excitation have been carried out on lines and in stations. The following oscillograms relate to a series of tests carried out on the 40 kV network of the "Pommern" bulk-supply station. Fig. 4 relates to a bus-bar flash-over at 380 kV surge voltage and its prevention by one of the above-mentioned arresters. The oscillogram (*a*) shows an oscillation which occurred without an arrester, and the oscillograph (*b*) shows the prevention of an oscillation by an Ozelite arrester. Fig. 5 represents a bus-bar flash-over in another station. The upper oscillogram (*a*) shows the effect of an Ozelite arrester (*b*), the effect of a flash-over without an arrester, and (*c*) the ineffectiveness of a horn-type arrester with high ohmic resistance. These oscillograms clearly indicate the prevention of the flash-over by an A.E.G. S A W arrester. These tests, which were also made on 10 kV stations, proved the theoretical protective action of voltage-dependent resistance arresters of various construction is actually attained, whilst equipment formerly adopted worked unsatisfactorily.

An attempt has been made above to show that the most dangerous over-voltages are caused by direct lightning strokes. Brief reference has been made to the proposals submitted in recent years for protecting overhead lines and plant. It remains to be seen from tests and working experience whether adequate protection can actually be obtained on the basis of the suggestions made. In the section of this article relating to the apparatus used for combating over-voltage phenomena, it was shown that the problem of energy-dissipation, which hitherto occupied a prime position, is not of great importance, and only of consequence for counteracting resonance phenomens. It has but little influence upon the reduction of the voltage, which is generally the chief factor aimed at. Another important result of the analysis is that it shows that some protective arrangements, as, for instance, intermediate cable sections of too short a length and choke coils of inadequate inductance are of no value. Apparatus possessing resistances that are greatly dependent upon the voltage has attained pre-eminence in recent times, and it appears that the development of apparatus of this type has provided protection against over-voltages and surpass all equipment hitherto known.

* "Performance of Thyrite Arresters," *General Electric Review*, 1930, page 350, by K. B. McEachron and H. G. Brinton.

A Self-Priming Pump.

FROM the Sihl Machine Works, Zürich, we have received particulars of a new self-priming pump built in accordance with the patents of Mr. H. Lauchenauer, a director of the firm. Pumps of this type have been made for various classes of service and one of them is shown in Fig. 1, whilst Figs. 2 and 3 indicate the principle of operation. Before putting the pump into service the pipe system is filled with water up to the level of the raised bend of the suction pipe, and once this has been done no further priming is necessary. When the pump is started water circulation takes place as indicated by the arrows in Fig. 2, and puts the suction injection A into operation.

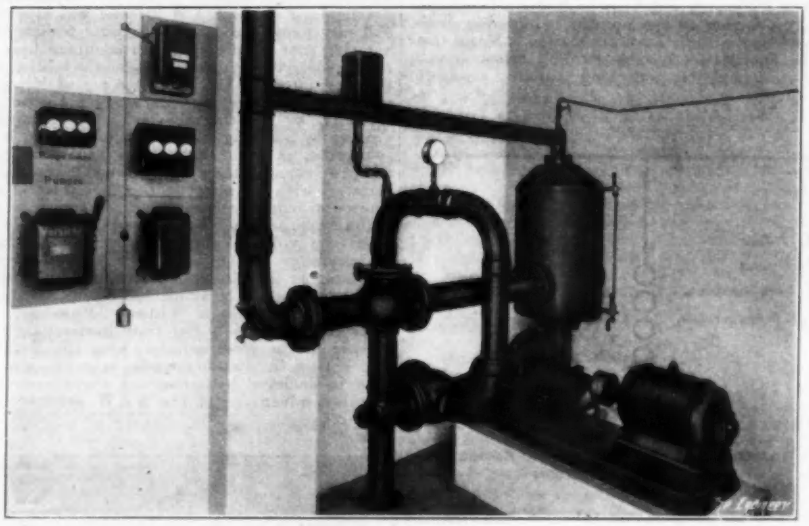
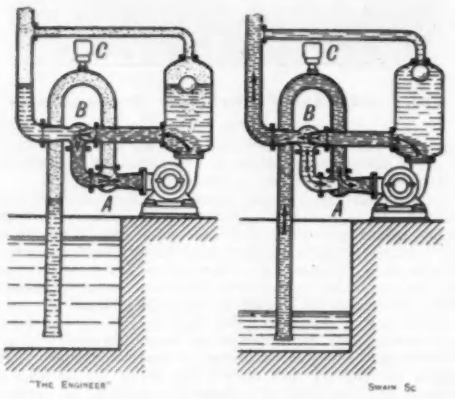


FIG. 1—SELF-PRIMING PUMP

Air entrained by the ejector is separated in the air separator and led away through the upper horizontal deaerating pipe into the pressure main. The deaerated water flows back to the suction ejector and more air is removed, until finally the suction pipe is deaerated. The time occupied in bringing about this condition may vary from a few seconds to a minute, according to the air content of the suction pipe, and immediately after the completion of the deaeration process the pump works with its full suction effect. The separator then fills with water and the ball float floating on the water closes the horizontal deaeration pipe, as shown in Fig. 3, so that the full quantity of water is driven through the pressure ejector B into A. At this moment the pressure ejector B works against the suction ejector A, and a state of equilibrium is established between the two ejectors, for the water circulation which occurred during the starting process is



FIGS. 2 AND 3—ACTION OF PUMP

stopped. The injectors are brought into action and put out of action quite automatically without the help of any auxiliary device.

At the top of the bend of the suction pipe, however, there is a deaerating device C, furnished with a small lifting magnet, which is connected in parallel with the motor. When the motor is switched off the magnet is de-energised and allows a sealing device to drop, so that air can enter the suction pipe and so prevent the water rising in the pipes and pump, which is therefore ready for operation again immediately the motor is started. The makers point out that, owing to the absence of valves on the pump, great reliability is ensured. Even when the suction pipe is not tight, or when air is occasionally drawn in, as may be the case with contractors' pumps, the suction ejector A comes into operation automatically at the right moment, for as soon as the normal quantity of water is no longer flowing through the pressure ejector, its effect is reduced, and a water circulation occurs that combines the starting and working conditions, until the suction pipe is once more completely deaerated. All danger of failure of the pump is said to be eliminated.

Pumps of this type have already been built for outputs ranging from 0·22 to 22 gallons per second, and for suction heads of 26ft., and for dealing with water from surface drains, sewage water, ammonia and tar, and carbide sludge. Extensive tests have been carried out by Professor R. Dubs, of the Zürich Polytechnic College, on a pump of this design, and his report concludes with the following statement :—

> As the main result of all these tests, it has been possible to establish that the additional losses in the ejectors, in the case of large quantities of water, are smaller than the losses in the suction valve, *i.e.*, the pump tested gave with the self-priming device better efficiencies than a normal design with suction valve. This result, which may be rather surprising at first sight, is to be explained by the high value of pressure losses in the suction valve, which make it impossible with such a design to deal with as large suction heads as with a pump with a self-priming device, such as built by the Sihl Machine Works.

In order to illustrate the principle of operation of the pump, the makers have had a glass model built, so that the action of the two ejectors can be clearly observed, and this model has been in operation at the Swiss Sample Fair at Basle.

The Vickers Showroom.

ON Thursday, May 28th, Vickers and the allied companies opened a showroom at Vickers House, Broadway, Westminster, in order that customers, and especially those from abroad, may inspect the firm's manufactures without having to leave London. The extent of the Vickers organisation can be gauged by the fact that it comprises more than twenty companies, some dating from before the war. Others were acquired during the war, or are the result of amalgamations or absorptions during the last few years of reconstruction. Obviously, no showroom could hold specimens of all the products of the Vickers organisation, even in the form of models, and all the establishment at Westminster is intended to do is to present those products which, from time to time, appear to be of outstanding interest.

Naturally, a good portion of the space is devoted to the productions of Vickers-Armstrongs, Ltd. Among the exhibits of this group is the Vickers-Armstrongs 75 mm. mobile anti-aircraft equipment, which is the most modern development of an anti-aircraft weapon, and for its weight and power is claimed to be the most accurate gun in the world. It has a maximum horizontal range of 15,200 yards, and a maximum vertical range of 30,300ft. A full-sized model of the Vickers-Armstrongs 75 mm. field gun with a transportable firing platform, which combines the qualities of an anti-tank gun with those of a field gun, is another prominent exhibit. It has a maximum range of 12,000 yards and fires a projectile of 14·33 lb. Among the smaller types of armament are specimens of the Vickers rifle calibre automatic gun—the standard land service machine gun—the Vickers-Armstrongs Colt automatic gun and the Vickers-Berthier machine rifle. Shells, fuses and cartridge cases of various kinds and in different stages of manufacture are shown, together with mines, &c. On the shipbuilding side the business is well represented by models. The Carden-Loyd machine-gun carrier, the standard machine-gun carrier of the British Army, is shown; also the "Carden-Loyd" tractor truck, which is an adaptation for commercial purposes of the Carden-Loyd military vehicle. The Marconi wireless installation for tanks, a Vickers-Schilovsky directional indicator for tanks, a Laryngaphone equipment for internal communication in tanks, a Siddeley engine specially built for Vickers tanks, and photographs showing the varieties of the larger types of tanks made by Vickers-Armstrongs, Ltd., constitute other exhibits.

The Thames Ammunition Works shows examples of shot-firing and blasting apparatus, and "Thameite" explosive. In addition to an aerial torpedo shown on an aeroplane fuselage, the Whitehead Torpedo Company exhibits a two-stage air compressor for air and oxygen, with a maximum delivery pressure of 195 atmospheres. A Vickers-Armstrongs-Straussler folding boat pontoon that is shown solves the problem of rapid bridging. A scale model of a complete cement plant, a working model of a Vickers-Gill axial flow pump, models of a 30-ton coal hoist, and the Norfolk spade, are illustrative of the activities of Vickers-Armstrongs in the heavy industries, while specimens of extruded metals, rolled sheets, strip, pressings, castings, high-pressure cylinders, &c., represent the company's capacities in other directions.

The most important products of the English Steel Corporation do not lend themselves to exhibition on account of their size, but an attempt has been made to show the part which the steels made by the Corporation played in the attainments of the world's speed records by Great Britain in the air and on land and on the sea. Taylor Brothers and Co., Ltd., have a fine exhibit of forged and rolled steel wheels for railway carriages, wagons and locomotives, disc wheel centres, axles, &c., whilst the Darlington Forge Company shows photographs of heavy steel castings and forgings such as stern frames and rudders for large ships. Industrial Steels, Ltd., also exhibits examples of its specialities. Like the products of the English Steel Corporation, those of the Metropolitan Cammell Carriage Wagon and Finance Company do not lend themselves to exhibition, and the exhibits, therefore, consist of models and photographs. Vickers Aviation, Ltd., show the part structure of an aircraft, the "Vildebeest," day-bomber and torpedo machine, which is equipped with the Vickers aircraft pilot's gun, the Constantinesco synchronising gear, and the Vickers-Berthier observer's gun. On the civil side of aviation there is a model of the Vickers-Vimy "Rolls-Royce" machine, which made the first direct Transatlantic flight in 1919, and a model of the Supermarine "Rolls-Royce," which won the Schneider Trophy in 1929.

Robert Boby, Ltd., of Bury St. Edmunds, has one of its patented two high malt mills on view. British Separators, Ltd., a subsidiary of Cooke, Troughton and and Sims, makers of optical and scientific instruments, exhibits a Vickeen oil purifier. The Ioco Rubber and Waterproofing Company, Ltd., with works at Glasgow, shows samples of mechancial rubber goods, including insulating materials, leather, cloth and rubber flooring.

The Vickers Train Lighting Company exhibits a plant for demonstrating the principle of the Vickers V 1 single-battery system of train lighting, whilst the Variable Speed Gear Company, Ltd., shows one of its hydraulic infinitely variable gears for gun-mountings, fire control gear, submarine equipment and a number of industrial purposes.

Besides the exhibits the showroom contains a valuable technical library, where brochures in English, French, German and Spanish, containing in handy form particulars of the principal manufactures of the group, together with other information, are available.

South African Engineering Notes.

Cranes for the Ports.

AMONG the latest additions to the equipment of the ports of the Union of South Africa is a 60-ton floating crane which has been agitated for by the shipping community at Cape Town for years. This crane is at present being constructed, and is due for completion in June, 1932. It is to cost £42,000, and is for use at Table Bay Harbour. The firm that is building it is also to supply a large portal jib crane at a cost of £5039 and thirteen 4-ton portal jib cranes at a cost of £29,850. All these cranes are for service at Table Bay Harbour. The wants of Durban Harbour have also received attention in the scheme of development, for an order has been placed for one 80-ton fixed electric crane. This crane is to be built at a cost of £11,930, and when completed will be erected at Congella Wharf. A new dredger, the "Reitbok," has arrived at Durban, and will replace the dredger "Nautilus." The "Reitbok" is the second largest dredger in the world. She is a twin-screw suction hopper dredger, with a length of 382ft. and a hopper capacity of 5000 tons. She is capable of dredging to a depth of 70ft. below water and can fill her hopper in under an hour. This new dredger has cost £161,000.

Next New Gold Mine.

Good progress is being made with the erection of the reduction plant at East Geduld, which will be the next gold mine to start operating on the Witwatersrand goldfield. The ore bins at the shaft head have been completed, and the slimes plant is well advanced. Mechanical transport from Geduld Station has been utilised in the transport of the plant, as there is no railway siding to the property. The permanent pumping plant, consisting of three centrifugal pumps, each capable of handling 40,000 gallons per hour, was installed at the 1100ft. level at the end of last year, and since then has done good service in coping with the flow of water from the dolomite, and has greatly facilitated sinking operations. Approximately 1¼ million gallons per day are now being handled. The primary and tertiary tube mills are in position, and the crusher house is nearing completion. The other sections of the 60,000 tons per month plant are all in an advanced state of construction, and there is no reason to doubt that the reduction plant will be ready at the appointed time. The completion of the reduction plant is expected to synchronise with the bringing of the main shaft into commission about the third quarter of this year, and if the present rate of progress be maintained, this expectation will be duly fulfilled.

New Sewage Outfall Works.

Cape Town is embarking upon a new sewage and storm-water scheme. Hitherto, sewage and storm water collected in the Green and Sea Point areas have been discharged by gravity at more or less sea level, *viâ* a number of large concrete ducts, built upon a shallow rocky promontory near the Green Point Lighthouse. Under the new scheme now in course of construction, this sewage and storm water will be pumped by means of "Stereophagus" pumps through a 27in. bitumen-lined and covered steel main, which will be laid nearly 1900ft. out to sea from the shore at a point some little distance from the lighthouse, where the sea bed consists of undulating sand. The end of the undersea pipe line will be in 55ft. depth of water, under which conditions the dilution of the effluent, after disintegration of solid matter by the pumps, will be sufficient to obviate entirely any cause for complaint. Arrangements are being made to use the existing concrete discharge mains for disposing of sudden rushes of sewage and storm water, which may be beyond the immediate

capacity of the main pumping sets running at the time of the "rush," and two motor-driven 18in. "Gargantua" disintegrators are being installed to break up finely all solid matter which may pass down with the overflow quantity under such emergency conditions. The main pumping plant consists of three 12in. and two 8in. vertical spindle "Stereophagus" pumps, rated at 2630 and 1200 gallons per minute respectively, against 28ft. total head. The pumps are by Hathorn, Davey and Co., Ltd., as are the "Gargantuas," and are driven by unity power factor motors of 45 B.H.P. and 22 B.H.P. continuous rating respectively. Stewarts Lloyds (S.A.), Ltd., are the contractors for the supply of the main pumping plant and structural steel work in the pump-house. The contractors for the laying of the pipe line are Messrs. McLaren and Eger. In order to compensate for unevenness of the sea bed, the pipe line is provided with flexible joints. It is being jointed upon the Green Point Common, and will be launched in one piece to facilitate which a tunnel has been made in the Beach-road at the launching point. After launching and sinking in position, the pipe line will be anchored by means of concrete blocks. This part of the work will be undertaken as early in the new year as conditions will permit.

FLOATING DOCK FOR WELLINGTON, NEW ZEALAND.

FROM the annual report of Mr. J. Marchbanks, M. Inst. C.E., General Manager and Chief Engineer to the Wellington (New Zealand) Harbour Board, which has just reached us, we learn that the Board last year ordered a new dock for the Port. The main particulars of the dock are to be as follows :—

Lifting power	17,000 tons
Overall length over platforms	584ft.
Overall length over pontoons	527ft.
Overall width	117ft. 6in.
Clear width between fenders	88ft.
Overall depth of pontoon	14ft.
Draught of water over keel blocks	26ft.
Corresponding freeboard of side walls	4ft. 3in.
Height of keel blocks	4ft.
Depth of water required at site	46ft.

Messrs. Clark and Standfield, of Westminster, who are the consulting engineers for the structure, obtained estimates for the building and delivery of the dock at Wellington, of which the following were the six lowest :—

	£
Swan, Hunter and Wigham Richardson, Ltd.	196,125
Harland and Wolff, Ltd.	200,265
William Hamilton and Co., Ltd.	211,500
Vickers-Armstrong, Ltd.	211,690
Sir W. G. Armstrong, Whitworth and Co., Ltd.	212,095
R. and W. Hawthorn, Leslie and Co., Ltd. (Palmer's Shipbuilding and Iron Company, Ltd.)	218,500

Six other tenders, which ranged from £219,900 to £281,000, were also received from Wm. Beardmore and Co., Ltd., the Fairfield Shipbuilding and Engineering Company, Ltd., the Furness Shipbuilding Company, Ltd., the Hong Kong and Whampoa Dock Company, Ltd., John I. Thornycroft and Co., Ltd., and the Walsh Island Dockyard and Engineering Works, of Newcastle, N.S.W. The lowest tender, that of Swan, Hunter and Wigham Richardson, Ltd., was accepted, and the dock is to be delivered at Wellington during March, 1932.

It is interesting to note that the value of the accepted tender is only £125 in excess of the estimate of the consulting engineers, which was £196,000.

It is also noteworthy that the receipt of this report should coincide with the launch of the dock, which took place from the yard of Swan, Hunter and Wigham Richardson, Ltd., on Saturday, May 30th.

THE NEWCOMEN SOCIETY.

THE Summer Meeting of the Newcomen Society will be held at Sheffield from Wednesday, June 10th, to Saturday, June 13th, 1931. London and district members will leave St. Pancras at 6.15 p.m. on Wednesday. On Thursday morning the members will assemble at Sheffield University at 9.30 a.m., when Professor C. H. Desch will discourse on "Old Sheffield Steel Working," after which an inspection will be made of relics of old Wortley Iron Works, old tools, plans, &c. At 10.30 a.m. a visit will be paid to Wilson's Snuff Mills, over which Councillor A. Harland and Captain Cecil Harland will conduct the party. At 11.30 a.m. Weston Park Museum, where the Curator, Mr. G. W. Baggaley, has arranged an exhibit of old Sheffield cutlery and wrought ironwork, will be visited. After lunch the party will leave for Elsecar, where the Newcomen pumps will be inspected—possibly under steam. Later, a visit will be paid to the steel works of B. Huntsman, Ltd. At 7.30 p.m. a dinner will be held at the Grand Hotel (Grosvenor Room) and a paper will be read on "John Curr, Pioneer of Iron Tram Roads for Mines," by Councillor Fred Bland. On Friday morning, at 9.30 a.m., a visit will be paid to Rivelin Valley, where methods of using water power will be inspected, including that employed at Mr. Wilson's flour mill at Malin Bridge. At 11 a.m. the works of Messrs. Tyzack, at Wadsley Bridge, will be visited, and at 2.15 p.m. the works of George Wostenholm and Sons, J. and W. Ragg, Ltd., and Joseph Rodgers and Son will be inspected. On Saturday, June 13th, a motor trip will be made into Derbyshire if a sufficient number of members decide to join the excursion.

THE TECHNICAL TRAINING OF FOUNDRYMEN AND PATTERN-MAKERS.—We are informed that the General Council of the Institute of British Foundrymen has now completed arrangements with the City and Guilds of London Institute, whereby new and up-to-date syllabuses have been drafted, and candidates who successfully pass the examinations will receive certificates of national reputation and recognition. The Institution of Mechanical Engineers, in conjunction with the Board of Education, has established a modification of the Institution's National Certificate in Mechanical Engineering suitable for students of foundry practice; this is of an advanced character, and the possession of this certificate constitutes a Diploma in Foundry Engineering of a very high grade. A number of technical colleges are already operating courses leading to this certificate.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

General Trade Position.

Now that work has been generally resumed in Midland and Staffordshire industries, it is possible to gather some idea as to the general trade position. Careful inquiries throughout the various manufacturing trades and in iron and steel-producing circles elicit the information that the industrial position commonly shows no marked variation from that existing during the few weeks prior to the holiday break. The basic trades are quiet, and with consumption well below normal demand for iron and steel shows no appreciable improvement. There are slightly brighter signs in some specialised quarters, but until they have developed they cannot affect Midland industry for the better. A trade fillip just now would be most timely, for undoubtedly the Midland and Staffordshire area is in need of one if present operations are not to be further curtailed.

Pig Iron.

There has been slightly more movement in the Midland pig iron market this week. Foundrymen appear to be finding business a little brighter, and encouraged by the recent concession in iron prices they are buying more freely. The movement is of no great magnitude, but it encourages hope of development during the current month. Business in foundry grades of iron remains mainly on a hand-to-mouth basis, but a moderate number of small sized orders have been placed, alike with Derbyshire and Northamptonshire blast-furnacemen. They have been heartily welcomed, and as a happier tone now exists in raw iron buying and selling circles, owing to the partial removal of grievances regarding selling prices, foundrymen will, no doubt, be as pleased to place orders as furnacemen will be to receive them. It is reported that Northamptonshire ironmasters are successfully competing with Cleveland makers in the Northern markets and that the position of local producers has been strengthened as the result of the determination of Cleveland smelters not to lower their prices further. Consumers in the North had, it is said, anticipated that the Midland lead would be followed by their competitors in that market. District forgemen say that there is no amendment of the trading position, nor can they see any prospect of improvement. They are using very little iron, indeed, and the market for this class of iron is of a most limited character. The Central Pig Iron Producers' Association continues to control selling prices, and furnacemen adhere strictly to the fixed minima. Derbyshire No. 3 foundry iron now commands £3 6s. and forge £3 1s., while Northamptonshire foundry is £3 2s. 6d. and forge £2 17s. 6d., all per ton delivered Black Country stations and subject to rebate to those who confine themselves to British material only.

Finished Iron.

The finished iron trade in Staffordshire remains under a cloud of depression, which nothing seems able to disperse. Recent efforts on the part of ironmasters to stimulate buying by means of reduced prices have failed to bring any response, and at date considerable difficulty is experienced in keeping the mills in operation. Activity is limited to some three days a week, and even at that level, normal staffs are not engaged. Not only is there a real shortage of business, but ironmasters have to contend with the difficulties appertaining to day-to-day orders, which almost eliminate the possibility of arranging definite rolling programmes. Small tonnage orders are the rule, consumers using up all the material at their command before ordering fresh supplies, delivery of which they want almost immediately. The marked bar mills share with the strip mills the most favourable position, if such it may be termed. There is a constant flow of orders in these branches, though, in the aggregate, they do not make an imposing total. Makers of best grade bars maintain their selling price at £12 per ton at makers' works, while wrought iron gas tube strip commands £10 17s. 6d. to £11 per ton, according to quality. In the merchant bar department keen competition exists for the small volume of business coming on to the market, and quotations vary considerably. While many Staffordshire rollers ask £10 per ton others are prepared to do business at £9 10s., while competitors from other districts intimate their willingness to accept £9 5s. Though the quality of Crown iron varies very much and Staffordshire material is notably good, under existing trading conditions price seems to be of greater importance to the buyer than quality; hence, a large proportion of the business done goes to ironmasters outside Staffordshire. There is very little call at date for common bars for bolt and nut and fencing manufacture. Black Country works are poorly employed, and of the material which they work up a good deal comes from the Continent. Belgian prices are so low as to make the Staffordshire quotation of £8 12s. 6d. appear prohibitive. Continental houses are as keen as ever to secure business, and local ironmasters have practically no chance. Only when British material is stipulated in the buyer's order to the manufacturer of the finished product is there an opening for Staffordshire common bar iron.

Steel.

The steel market shows no change on the week. Business is slow in all departments and steel works in this district are short, both of orders and specifications. Much time is wasted in roll changing and profitable production is difficult. Orders are for a few tons at a time. Special steels for the automobile industry probably furnish, proportionately, the greater volume of business being done. All sections of engineering, including rolling stock establishments, are taking less material than is normally the case. Plates are in poor request alike for structural purposes and boiler-making. Finished steel values are unaltered, angles being quoted £8 7s. 6d., tees £9 7s. 6d., joists £8 15s., ship, bridge and tank plates £8 17s. 6d., all per ton, less their respective rebates to users of British steel exclusively. Boiler plates are quoted £9. There is so little business being done in uncontrolled steel that it is difficult to name prices. A good order would, undoubtedly, bring a concession in such products as billets and small steel bars. Some very low offers have been accepted under pressure to sell. For re-rolled steel bars £6 10s. is reported to have been taken, and for all-British bars £7. These prices do not, of course, indicate the general market level, but they illustrate the conditions ruling. The market for continental steel is quiet, and in the absence of any widespread inquiry, prices are weak. Birmingham and Midland merchants are doing only very small-scale business.

Galvanised Sheets.

The decontrol of galvanised sheet prices and the return to free competition for business in overseas markets, has brought some additional business to local mills, and inquiries now in circulation encourage the hope of greatly improved trade in the near future. Much, of course, depends upon the satisfactory completion of negotiations as to terms. Makers have a free hand to quote as they will, and, no doubt, they will make concessions for good orders. They are now in a better position to compete in overseas markets which account for a large proportion of the galvanised sheet output, and Belgian producers should not have it quite so much their own way in the future. The selling figures quoted in my letter last week represent the present market value as far as can be ascertained. Galvanised corrugated sheets of 24-gauge make from £10 5s. to £10 10s. per ton f.o.b. for export. The home demand is maintained at recent levels.

Steel Scrap.

There is no improvement in demand for steel scrap, and the market remains practically lifeless. Very few sales are being made and it is impossible to quote any definite level of prices. Birmingham merchants have made many offers to South Wales users, but although the prices named have admittedly been very low, the offers have not been taken up. Some works are reported to have heavy stocks, while others have little prospect of being able to use up anything but meagre tonnages in the immediate future.

Worcester Can Factory.

Lord Cobham, on the 27th ult., formally opened the new large factory of G. H. Williamson and Sons, Ltd., Worcester, in which is to be made open top cans for canning British fruit, vegetables, cream, &c. The industry, which is new to Worcester, has an undoubted future, and it is, therefore, interesting to note some of the details of this modern factory. It has cost nearly a quarter of a million sterling to complete, and has a floor area of 100,000 square feet, the site covering nearly 20 acres. It is capable of an annual output of over a hundred million cans, which can be produced at the rate of 1200 a minute. Every operation, from the time the tin-plate is cut to the correct size until the finished cans leave the factory, is automatic, the cans never being touched by hand. A conveyor system 2¼ miles in length, carries the cans from one machine to another. There is a battery of ovens, of a type never before installed in this country, capable of lacquering 1900 sheets of tin per hour. The body-making machines transform the flat sheet of tin into an almost complete can, faster than the onlooker can follow its progress, while testing machines eliminate the possibility of defective cans leaving the factory.

Electricity Progress in Birmingham.

The Birmingham Electric Supply Department has now attained the position of the second largest undertaking of its kind outside London, the number of customers now taking supplies exceeding 100,500. Great progress has been made during the past ten years. In 1921 the total number of consumers was 13,500; five years later—in 1926—the total stood at 37,100, whereas the present total is 100,500. The 18,933 additional premises coupled up to the supply mains during the past year exceeded the total number connected in the whole of the twenty-three years from 1900 to 1923.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

Bridging the Dee.

THE scheme for bridging the estuary of the river Dee, about which so much was heard three or four years ago, has not apparently passed into the region of forgotten things, for the Unemployment Sub-committee of the Liverpool Corporation Finance Committee is now taking an active part in the furtherance of the scheme, which is estimated to cost something like £6,000,000. Whether or not the project will eventually mature is problematical, but there is no doubt that, in these days of rapid transport, a journey between North Wales and that portion of Lancashire and Cheshire situated in the region of Liverpool and Birkenhead entails an expenditure of time altogether out of proportion to the distance "as the crow flies." For instance, as things are, the traveller from Liverpool to North Wales must make a detour *viâ* the Cheshire bank of the Dee through Chester, and along the Welsh bank, a journey which would be reduced by about 30 miles if the proposed bridge were in existence. An amplified report on the scheme is being furnished by the Unemployment Sub-committee to the Minister of Transport. In a few words, the scheme provides for the construction of two embankments and a connecting bridge, altogether about 4 miles long, extending from Hoylake on the Cheshire side to Talacre on the Welsh side. The Unemployment Sub-committee has also requested the Liverpool City Engineer to furnish a report on a scheme which has been put forward to link up by means of a tube railway the various railway stations in the city area.

Preston Bridge Scheme.

Lancashire County Council and Preston Corporation are to join in a scheme for widening Brockholes Bridge, Preston, to cope with traffic on the Blackburn new road. The total cost is estimated at £40,000, and a grant of 60 per cent. is to be made by the Ministry of Transport.

Non-ferrous Metals.

The fact that little change has occurred in the position of non-ferrous metals supplies in relation to the demand, has induced a fresh spell of weakness in all sections. Fresh "low" points continue to be touched, but, in spite of the cheap rates at which all the non-ferrous metals are being offered, users are showing little disposition to venture forward. At the moment of writing, tin is fractionally above the worst point touched during the past week, but the price is still as near to £100 a ton as it well can be without actually breaking that figure. Purely as a matter of historical interest, it may be recalled that this metal exactly two years ago had just fallen below £200, whilst in the first half of 1927 the price was hovering above or below £300. In contrast, the records show that last week's values are the lowest seen for about thirty years. The supply position continues to be acutely "bearish," and users seem to be no more anxious than before to venture beyond immediate requirements. More or less similar conditions obtain as regards copper, and selling competition is the dominant feature of this section. In spite of spasmodic rallies prices are lower on balance for the week by between £2 10s. and £3 a ton. Heavy stocks of lead are pressing on the market, and with the industrial demand of modest dimensions, quotations are lower by about 10s. on the week. Spelter sales are also poor, and although current values are a shade above the worst of the week, the net loss ranges from 12s. 6d. to 15s. a ton, with prices lower than at any time before.

Iron and Steel.

Up to the present, no improvement in iron and steel trade conditions has succeeded the holidays, the local markets having reopened on a very quiet note. Pig iron makers are still faced with the competition of low-priced machinery scrap, and although in one or two instances the position of individual foundries in Lancashire is believed to be better than before, sales of iron are restricted, and it is doubtful if the aggregate quantity involved is heavier. Staffordshire, Derbyshire, and Cleveland No. 3 irons are quoted on the basis of 67s. per ton, Northamptonshire at 65s. 6d., Scottish makes at from 88s. to 88s. 6d., and West Coast hematite at 82s. 6d.—all for delivery to users in the Manchester district. No more than a quiet business is passing in manufactured iron, with Lancashire Crown quality bars quoted at £9 15s. per ton, and seconds material at about £8 5s. Steel rollers are disappointed at the continued absence of forward contract buying. Apart, however, from the unsatisfactory state of the principal consuming industries locally, it is now doubtful, in view of the agitation of shipbuilders for cheaper British materials, whether any departure from the policy of hand-to-mouth buying, which they have pursued for so long, will be made by users in this area. Boiler plates are quoted at from £8 17s. 6d. to £9 per ton; small re-rolled bars, at about £6 15s.; joists at £8 15s.; sections at £8 7s. 6d.; general plates at £8 17s. 6d.; and 3in. and upward bars at £9 7s. 6d. Sellers of continental iron and steel products are keenly competing for the small business that is available locally, and still lower prices are being indicated, imported billets and sheet bars being at from £3 15s. to £4 per ton, angles at £4 14s., Siemens plates at £5 12s. 6d., joists at £4 11s. 6d., steel bars at £4 14s., and No. 3 Belgian iron at £4 14s.—all for delivery in the Manchester district.

BARROW-IN-FURNESS.

Hematites.

There is rather a weak tone in the hematite pig iron trade of North Lancashire and West Cumberland. The run of business is really small, and buyers are not making any effort to do more than cover their immediate requirements. At Barrow, the two furnaces have been damped down temporarily, and some necessary repairs are being done. Local wants are fair and there is not much trade on offer on continental account. American business is in the background. More iron is being made than can be sold and the stores in makers' yards are on the increase. There are no signs of any improvement in the immediate future.

Iron Ore.

There is a lessened demand for hematite iron ore. The demand is mostly on local account, with some best grades going to other districts.

Steel.

The condition of the steel trade is not good. The demand for steel rails is dull, on both home and overseas account, and next to no business is moving. There is a fair demand for hoops and strips, and castings are in moderate request. At Workington there is a fair amount of activity, but at Barrow there is a marked quietness.

SHEFFIELD.

(From our own Correspondent.)

Conditions Continue Quiet.

WITH the beginning of this week the resumption of operations in the steel trade, after the Whitsuntide stoppage, was complete—or as complete as it could be under the prevailing conditions. Work was recommenced on about the same scale as that on which it was left off, which is to say, a very moderate or poor scale. As a result of recent reductions in prices of raw materials and in wage rates, together with derating, the costs of producing steel have been sensibly lowered, so that British firms are favourably placed for competing for trade when a revival takes place; but there is no revival in sight yet. The poor state of the open-hearth steel department is shown by the fact that the United Steel Companies, at their great works at Templeborough, have only five furnaces working out of a total of 14. Production in Lincolnshire is slightly down. On the heavy manufacturing side the engineering shops are still without contracts of importance. The shops devoted to the production of railway axles, tires and springs, could do with a great deal more work, as both home and foreign companies are still giving out orders on the meagre scale that has prevailed for a considerable time. Local firms are showing activity in their efforts to secure a full share of the large orders which will be distributed very shortly in connection with the Chinese Boxer Indemnity Fund.

The Price of Shipbuilding Steel.

The demand for shipbuilding steel is very quiet, and it would appear, from recent statements of the Shipbuilding Employers' Federation, that it is likely to continue so unless prices are sensibly reduced. The Central Board of the Federation has been calling attention to the fact that the rebate, which was fixed a few years ago, is no longer of much advantage to the shipbuilders in this country. For several years practically all the British shipbuilding firms have been parties to the scheme with British steel makers, by which, in return for an undertaking to purchase exclusively from British makers, a rebate of 15s. per ton on the fixed prices was granted. When this scheme was entered into, with the advantage of the rebate, there was very little difference between the price of British and foreign steel, but it is now stated that foreign shipbuilders can buy continental steel more cheaply that British shipbuilders can buy foreign steel, and that foreign steel for shipbuilding is being delivered in Great Britain at nearly £2 per ton under British prices. It is urged that the present disparity is a great handicap to British shipbuilders in their competition with foreign builders, who are obtaining much of the restricted amount of new business available as a result of their ability to quote on the basis of cheap foreign steel. The Central Board of the Employers' Federation has resolved to renew its representations to the British steel makers on the vital necessity of an early reduction in their prices.

The Lighter Side.

On the lighter side of the steel trade some exceptions can be found to the general dullness, but they are few. One of them is the stainless and corrosion-resisting steel branch, which continues to turn out a large volume of products for many and varied engineering purposes, though it has failed to show any expansion of late. The requirements of the motor industry, in forgings, pressings and special steel, although substantial, are no longer nearly equal to what they were a couple of years ago, and many firms are suffering as a result of the reduction. There is little fresh to say about the condition of the tool steel and tool branches. While the home demand is moderate, overseas trade continues at a low ebb, and that fact is having a marked effect on the aggregate output. The market for ferro-alloys is disorganised. Makers have accumulated stocks, owing to production having exceeded demand for a long period, and low prices are being offered in the hope of tempting speculative business. Official quotations are only nominal, and in a number of cases materials are being sold at less than cost. Even this inducement, however, has not brought forward much business. There is so little prospect of an early improvement in trade that users do not feel inclined to place orders for more than their daily needs.

Good Orders from Russia.

This week's news includes interesting items about the placing of orders, in both Sheffield and Gainsborough, by the representatives of the Soviet Government. The principal order received in Sheffield is one booked by Spear and Jackson, Ltd., for circular saws of the value of £25,000. The saws are for use in saw mills, and the order is the largest of its kind ever known in the trade. Russia has bought hundreds of thousands of Sheffield saws in past years, but they have chiefly been cross-cut saws for use in lumbering. That trade has almost ceased in recent years, and there has also been a great decline in business in files, for which Russia was formerly Sheffield's largest overseas customer. In both these cases the explanation is given that Russia's needs are now largely met by the production of her own factories. Hopes are entertained that business in engineers' small tools and edge tools may be received during the summer, and it is understood that another big order for circular saws is likely to be placed shortly. The Gainsborough news with regard to Russia is an amplification of my last week's announcement of an order for machinery received by Marshall, Sons and Co., Ltd. It is now learned that the contract is for 175 portable locomobiles, valued approximately at £100,000. Twenty-one months' credit is being allowed. Delivery is to be made by the end of September.

Important Appointments.

Sheffield is about to lose one of its foremost metallurgical figures in Dr. Cecil H. Desch, F.R.S., Professor of Metallurgy and Dean of the Faculty of Metallurgy at the University, a man who has done much in the city and elsewhere for the scientific study not only of iron and steel, but also of non-ferrous metals. He has been appointed Superintendent of the Metallurgical Department of the National Physical Laboratory, and will take up his new duties in February, 1932. He came to Sheffield from Glasgow in 1920, to succeed Professor J. O. Arnold. Another prominent local metallurgist who has received an important new appointment is Mr. W. R. Barclay, the managing director of Henry Wiggin and Co., Ltd., nickel silver manufacturers, Sheffield, who has been appointed consulting metallurgist to the Mond Nickel Company, with headquarters in London. For the past 14 years Mr. Barclay has carried on business for Messrs. Wiggin and Co. from their Birmingham branch. During the war years he was manager of the silver and electro-plate department of Joseph Rodgers and Sons, Ltd., Sheffield, and also travelled extensively for the Ministry of Munitions. He has lectured frequently at Sheffield University on metallurgy, and is a Past-president of the Institute of Metals.

Lincoln Pumps for Southampton Dock.

Lincoln is to make the great pumps for the dry dock which the Southern Railway Company is building at Southampton to accommodate the new 70,000-ton Cunard liner, which is expected to be completed in 1933. The contract for the pumps has been obtained by Gwynnes' Pumps, Ltd., and the plant includes four 54in. pumps and three 18in. pumps, with an output of 24,000,000 gallons per hour. The work will probably engage the Lincoln shops of Foster and Gwynnes for a year or 18 months. Messrs. Gwynnes have for some time been engaged on a contract for the Middle Level Drainage Commissioners, to make three pumps with a diameter of 102in. These pumps will be used for lifting drainage water over a tidal barrage at the Ouse outfall. They will be among the biggest pumps in the world, and will have a combined output of 840,000 gallons per minute.

Cutlery for South America.

The cutlery and electro-plate trades show little change. There is much scarcity of work in connection with ordinary home trade, and the export demand is also seriously down, especially that with the Australasian markets. Substantial orders continue to be received from restaurants and hotels, but the volume of business for the cheap bazaars shows a falling off. A large bulk of goods is still being turned out for coupon distribution, but this business again is not up to past standards. An item of special interest is that Sheffield has received its first order as a direct result of the Buenos Aires Trade Exhibition. This is for 10,000 table knives, which, it is stipulated, shall be made by a Sheffield firm. The buyers—who have asked the local secretary of the F.B.I. to place the order for them—state that previous to the Exhibition orders were placed with continental manufacturers, either at Hamburg or Paris.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Slump.

THE continued absence of business of any note in the iron and steel trades is causing grave anxiety in this district. Inquiries for one or two commodities are perhaps just a shade better than of late, but in all departments orders are much needed, and conditions generally are unsatisfactory and discouraging. Producers are unwilling to reduce quotations, declaring that ruling rates barely cover cost of output, but consumers are becoming more disinclined to pay recognised market figures for the small parcels to meet their needs and an early fall in values is expected. There was a decrease of about 9000 tons in the May exports of manufactured iron and steel from the Cleveland district. In the earlier months of the year the exports of steel were swollen by the execution of substantial rail orders for South Africa, but they have now been completed, and the total shipments to South and East African ports fell from 20,761 tons in April to 5441 tons in May. Chiefly owing to this contraction in the South African trade, the manufactured iron and steel shipments from Cleveland fell from 45,818 tons in April to 36,332 tons in May. This latter figure, however, is still about 5000 tons above the January and February totals. Foreign shipments of pig iron from the district in May amounted to 4031 tons, compared with 4831 tons in April, whilst coastwise shipments reached 7785 tons in May, which compared with 6721 tons in April. Thus the aggregate shipments of all descriptions of iron and steel for May reached a total of 48,148 tons, as compared with 56,370 tons in April. Imports continue on a heavy scale. Statistics presented at this week's meeting of the Tees Conservancy Commission give the aggregate imports of iron and steel during May at 14,490 tons, comprising 3881 tons of pig iron, 9446 tons of crude sheet bars, billets, blooms, and slabs, and 1163 tons of plates, bars, angles, rails, sheets, and joists, as compared with total unloadings in May of last year of 11,723 tons.

Cleveland Iron Trade.

The Cleveland pig iron market is extremely quiet. New business matures slowly, and there is not the slightest sign of improvement in the outlook. A blast-furnace at the South Bank Works of Dorman, Long and Co., Ltd., has gone out for repairs, and as the demand for iron is so limited, it is not being replaced. The present production is slightly in excess of moderate requirements, and stocks, while only light, are slowly but steadily increasing. A few small sales have been made to Scotland at prices well below cost, but makers decline to cut prices elsewhere, and they are being undersold by foreign competitors, both at home and also in neutral markets. No. 1 Cleveland foundry iron is 61s., No. 3 G.M.B. 58s. 6d., No. 4 foundry 57s. 6d., and No. 4 forge 57s.

Hematite Pig Iron.

Business is also quiet in the East Coast hematite pig iron trade. Gjers, Mills and Co. are once more producing hematite at their Ayresome Ironworks, Middlesbrough. While the output of the two blast-furnaces which the firm has rekindled is understood to be for old customers, some of the additional make is expected to come on to the market, and thus larger additions to stocks are threatened. Prices are not definitely fixed, and terms of sale vary a good deal. Second hands are securing occasional small orders by price cutting, but are doing next to no business. Manufacturers endeavour to keep recognised market rates on the basis of ordinary qualities at 65s., but consumers experience no difficulty in covering their needs at less. No. 1 quality is at a premium of 6d. per ton.

Iron-making Materials.

There is virtually nothing being done in the foreign ore trade. Consumers are well placed as regards supplies, and are off the market. Best Rubio ore is in the neighbourhood of 17s. 3d. c.i.f. Tees. Blast-furnace coke is slow of sale. Supply is abundant, but while sellers are pressing business at 15s. 6d. for early delivery of good average sorts, they are not disposed to make forward contracts at that price.

Manufactured Iron and Steel.

In most branches of the manufactured iron and steel trade scarcity of orders is as acute as ever, but firms have now a good deal of constructional steelwork on hand. Depression in shipbuilding is responsible for the extreme slackness in certain branches. The 10s. drop in the price of galvanised corrugated sheets has not induced buying of moment.

Ironworkers' Wages Increased.

The ascertainment of selling prices in the North of England Manufactured Iron Trade shows an advance of 6s. 4½d. per ton. Under the sliding scale there will be an advance of 2½ per cent. in puddling and other forge and mill wages as from Monday for the next two months. The steel smelters' wages sliding scale ascertainments for the three months ending March show a net selling price of £7 18s. 2·34d. per ton. This means that there will be no change in the sliding scale percentage for the next three months.

The Coal Trade.

Trading conditions continue dull in all sections of the Northern coal market. The trade position was irregular throughout May, and June promises nothing better, unless something occurs to give a fillip to the demand. Durham has experienced a slack time for weeks, and now Northumberland shows signs of a considerable falling off in the inquiry. Circumstances vary greatly as a result of the working of the marketing scheme under the Coal Mines Act. There are collieries in Northumberland which have reached their quota of output, but could sell more if they had freedom to do so. The last month of the quarter has been entered, and pits which have disposed of their production above the limitation line have now to ease down in order to avoid fines for exceeding their allowance. The sales have been mostly for large coals, as there are huge accumulations of smalls, which come into the aggregate of production, though the market for them is of the dullest kind. In Durham County the trade has been so indifferent during the past two months that only a very few collieries are up to the quota mark. From now until September the home coal demand is likely to be on moderate lines, and foreign orders are difficult to get, owing to sharp competition, and the minimum prices, which are known abroad, can be undercut as opportunity offers. The decline in trade is shown by the decrease in shipments, those from the Tyne for the last five months being considerably over a million tons less than the corresponding period of 1930. Northumberland steam coal is now being offered plentifully for any part of this month's shipment, and buyers have no trouble in covering any commitments at the fixed minimum price of 13s. 6d. for best qualities and 12s. for seconds. Durham gas coal for both home consumption and export is in slow demand, and although sellers ask the schedule price of 14s. 6d., buyers are holding off. Bunker coal is in fairly good demand at 13s. 6d. for ordinary, but with ample stocks available, prices remain just steady. Coking coal shows no sign of any increased demand. There is nothing in the general industrial conditions to help the coke makers. Two blast-furnaces have been rekindled in the Teesside area, and another is about to go out of operation, which will leave a total of twenty-two working. The demand for blast-furnace coke is no greater, and the price is unchanged at 15s. 6d. for prompt delivery. Ordinary patent coke is in large supply at 15s., 18s. to 20s. being asked for superior classes. Gas coke is fairly steady at the unchanged price of 19s., and beehive descriptions are in wide range at 20s. to 24s.

SCOTLAND.

(From our own Correspondent.)

Shipbuilding.

THE output from the Clyde during the month of May was comparatively good, the returns amounting to six vessels of 31,500 tons aggregate. Among the launchings, the most important was that of the twin-screw turbine passenger and cargo steamer "Corfu," built for the P. and O. Company, the gross tonnage being 13,900. Other vessels of note were the "Cliona," motor tanker, 8220 tons, for the Anglo-Saxon Petroleum Company, Ltd., London; and the "Karabagh," motor tanker, 6650 tons, for the Baltic Trading Company, Ltd. The past month brought little in the way of fresh contracts, the only orders reported being one for a vessel of 1350 tons for the Leith–Hamburg service of Messrs. James Currie and Co., and engines for a similar ship, the hull of which is to be built at Leith. Along with the "Corfu," just launched, Messrs. Alex. Stephen and Sons, Linthouse, have got to complete a sister ship, the "Carthage," and these vessels will be the largest to be built on the Clyde this year.

Steel.

In consequence of a slightly better inquiry, prospects in the steel trade appear to be a shade better. Though partial time is still the rule at the works, it is said that the volume of work is inclined to increase. The dearth of shipbuilding orders continues to play a prominent part, and unfortunately there seems little chance of improvement here for some time to come. Orders for heavy steel, therefore, are most disappointing. Tube makers report a better home demand, but deplore the lack of export orders. Black steel sheets are not doing particularly well, and galvanised descriptions are not showing much improvement, notwithstanding the removal of the Australian embargo. That the need for co-operation in the industry is recognised has been shown by the combination of the interests of Messrs. Colville, Beardmore, and Dunlop, with the production concentrated at the Colville Works.

Iron.

Makers of bar iron and re-rolled steel bars have nothing fresh to report; business, both on home and export account, shows no sign of expansion. Prices are unchanged, though the export quotation of £9 15s. for Crown iron bars could be shaded if a suitable order were on offer. Re-rolled steel bars are nominally unchanged at £6 10s. home and £6 7s. 6d. per ton export. Pig iron is a very dull market, owing to a poor demand, and continued imports from India and the Continent. Over 2000 tons of pig iron from Calcutta were unloaded at Queen's Dock, Glasgow, last week. Shipments of pig iron from Glasgow last week amounted to 365 tons (304 tons foreign), compared with 184 tons in the same week last year.

Scrap.

The market for scrap shows further weakness, with quotations at 50s. for cast iron machinery and 40s. per ton for heavy steel.

Coal.

The tone of the coal market is a shade steadier, owing to a further reduction of outputs. Business shows no improvement in either the home or shipping departments, and most qualities of fuel are obtainable slightly below current quotations. The larger sizes of washed nuts have become scarce, especially in Fifeshire, and the price is inclined to harden a trifle. Aggregate shipments amounted to 214,196 tons, against 200,188 tons in the preceding week and 244,585 tons in the same week last year.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

The Coal Trade.

CONDITIONS generally in the coal trade have not improved since the Whitsuntide holidays—indeed, they have been disappointing, and the outlook is far from promising. When work was resumed in the coalfield immediately following the recent vacation, the report from the docks showed that at the leading ports there were as many as 35 idle tipping appliances, from which it will be seen that tonnage arrivals were much below what was expected or required to give strength to the coal position. It is not surprising, of course, that with three days' holiday in the coalfield and work at the docks suspended for two whole days, there should be a material diminution in coal exports from this district last week. According to the Great Western Railway Company's returns the total for the six ports over which it has control was 244,600 tons, which compares with 493,700 tons for the previous week. What, however, proved most disappointing to all engaged in the export trade was that the general inquiry from abroad proved no better after the vacation than it was before, if, indeed, it has not been more restricted. There are very definite reasons for the curtailment of the foreign demand, though hopes are entertained that in some directions at any rate the cessation of operations may be only temporary. France is doing its utmost to encourage the increased consumption of its own production; stocks of native coal in Belgium are greater than they have ever been and are reported to run to 3 million tons, while the unsettled conditions prevailing in Spain, financial and otherwise, are factors which have an important bearing on the inquiry for coals from this country. It need only be mentioned that so far as Spain is concerned the record depreciation of the peseta—it at one time this week touched 62½ to the £—has been sufficient to bring business practically to a standstill, and it may be some time before the position materially improves. Another disappointment in store was a surprising development in connection with the inquiry from the Egyptian State Railways for 200,000 metric tons of locomotive coals for delivery at Alexandria over the next three months. Firms had been asked to tender for 100,000 or 200,000 tons on an f.o.b. or c.i.f. basis, and the tenders were to be opened at Cairo on Tuesday, but the day before the news was received that the authorities had definitely decided to postpone the adjudication and to return the tenders received without opening them. Naturally, there has been considerable speculation as to the reason for the action adopted by the railways. In some quarters it is thought that the railway authorities have taken this course in the expectation that in a month or so there is a prospect that lower prices might be offered, while in other quarters it is reported that the postponement may have something to do with a scheme which the Egyptian Government is credited with entertaining, of forming a national merchant fleet, which may possibly explain why, on this occasion, the authorities asked for quotations on a f.o.b. and c.i.f. basis.

Coalfield Audit.

According to the secretary of the South Wales Coalowners' Association, the outstanding feature of the report of the joint accountants for this coalfield for the three months ended April last is the alarming decline in the volume of production. It gives a total quantity produced during the period of the audit of only 9,750,732 tons. This total is the smallest recorded since the audit period ended August, 1925, and shows a decrease compared with the output in the three months ended April, 1930, of 1,484,323 tons, or 13·2 per cent. On an annual basis it represents a production of only 42 million tons, or about 3·8 million tons less than the actual output in 1930, and 15 million tons below the production of nearly 57 millions in 1913. The trading results under the audit for the February-April period show an excess of 2·32d. over the total costs of production. Colliery owners, however, have to meet certain capital charges that are inadmissible under the terms of the wages agreement, and it is estimated that these charges amount in South Wales to about 9d. per ton. The wage percentage certified by the auditors under the formula laid down in the agreement is only 5·81 per cent. on the 1915 standard rates. The agreement provides for a minimum percentage of 20, and the difference between this rate and the certified economic wage of 5·81 on the standard rates must be met by the coalowners. The pit-head proceeds per ton declined during the three months by nearly 3½d. per ton, principally because of the fall in prices and diminished sales of small and sized coals. The depression in the iron and steel industry, and particularly in the pig iron branch, has largely deprived the coalfield of its principal output for smalls, and the stocks of these coals at present accumulated at the pit-head and other places are probably greater than at any other period in the history of the coalfield.

Floods and Damage.

South Wales and Cardiff in particular were visited on Wednesday night last week by a storm which, for its severity, exceeded anything known for 40 years. In about four hours over 4in. of rain fell and resulted in floods and damage running into thousands of pounds. In the eastern section of Monmouthshire collieries were considerably affected, and at some pits it will take close upon a fortnight before normal work can be restored. The movement of coal was interrupted for some time owing to damage to sidings and railways. So far as Cardiff is concerned, owing to the loss sustained by business men and residents, many of whom are not covered by insurance, the Corporation is likely shortly to take important decisions concerning the question of supplementing the existing drainage system and other measures for preventing flooding, which, roughly, will entail an expenditure of a quarter of a million pounds.

Tin-plate Trade.

Speculation has been rife as to whether the abandonment of the South Wales tin-plate pool and the withdrawal of firms associated with the South Wales Tin-plate Corporation would have any effect upon the agreement with America. It is now reported that it will have no effect, as the period originally fixed for the operation of the agreement between this country and America terminates on September 30th next, and that already negotiations have been commenced with a view to its continuance.

Current Business.

The tone of the market is extremely quiet, and there has been no variation in prices except that, so far as Eastern Valleys large are concerned, because of the restricted production, prices have been advanced 3d. per ton. In all other directions prices are at the minima, while patent fuel and coke display no feature and pit-wood remains at round about 22s. 9d. to 23s. The report has appeared that because of the curtailment of shipments of coal it was the intention of the G.W.R. Company temporarily to close the Penarth Docks, but this report has been officially denied.

CATALOGUES.

HENRY SIMON, Ltd., Cheadle Heath, Stockport.—"Granaries and Grain Handling Equipment."

BUTLER MACHINE TOOL COMPANY, Ltd., Halifax.—Sheet No. 3 on the high-production slotting machine.

FESCOL, Ltd., 101, Grosvenor-road, S.W. 1.—Lists of the industrial applications of the "Fescol" process.

RHEOSTATIC COMPANY, Ltd., Slough.—Pamphlet on "Heat Control," describing some standard thermostats.

POWER PLANT COMPANY, Ltd., West Drayton, Middlesex.—Particulars of the "Rapiducer" combined gear and motor unit.

MACTAGGART, SCOTT AND CO., Ltd., Loanhead, Glasgow.—A catalogue on extending structure type catapults for launching aircraft.

ALFA-LAVAL COMPANY, Ltd., 34, Grosvenor-road, S.W. 1.—"The Secret of Successful Operation of Internal Combustion Engines."

TAYLOR STOKER COMPANY, Ltd., Bush House, Aldwych, W.C.2.—A descriptive catalogue of stokers for power stations and industrial plants.

STURTEVANT ENGINEERING COMPANY, Ltd., 147, Queen Victoria-street, E.C. 4.—General catalogue of air systems and plants, fans, &c.

ROSE, DOWNS AND THOMPSON, Ltd., Old Foundry, Hull.—List 7 of trawling winches, fishing winches, fairleaders, and "Adamanto" sheaves.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, Ltd., Trafford Park, Manchester.—Special publication, 7826/11–1, dealing with ship's generating sets.

ENGLISH ELECTRIC COMPANY, Ltd., Stafford.—The following publications: M. 52, "Back-pressure, 10,000 kW Steam Turbine Generators for Yallorn, Victoria"; M. 14, "Feed-water Heaters"; M. 44, "Streamline Cylindrical Balanced Valves"; 934 A, "Air-break Starters, Class A S for Squirrel-cage motors."

THE ENGINEERING TRADES ON MERSEYSIDE.—The third of a series of pamphlets which is being issued by the Liverpool Education Committee—in co-operation with other local education authorities on Merseyside and the Ministry of Labour—dealing with the various occupations open to young people in the area, lies before us. The primary aim of the series is to provide parents, teachers, social workers and others with the detailed information that will enable them to advise young persons of school leaving age or over in selecting their future careers. But an important secondary aim is to stimulate on the part of young people themselves an intelligent interest in their future occupations; and it is with this aim in view that in the present handbook short historical and descriptive notes have been included in the text. In an attractive manner, fitted for the general non-technical reader, illustrated descriptions are given of the engineering trades of Merseyside and of the facilities for technical education.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. COAST—	
(1) Native	16/– to 20/6
(1) Spanish	16/–
N.E. COAST—	
Native	18/– to 21/–
Foreign (c.i.f.)	15/3

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) SCOTLAND—		
Hematite	3 12 0	—
No. 1 Foundry	3 16 0	—
No. 3 Foundry	3 13 6	—
N.E. COAST—		
Hematite Mixed Nos.	3 4 0	3 4 0
No. 1	3 4 6	3 4 6
Cleveland—		
No. 1	3 1 0	3 1 0
Siliceous Iron	3 1 0	3 1 0
No. 3 G.M.B.	2 18 6	2 18 6
No. 4 Foundry	2 17 6	2 17 6
No. 4 Forge	2 17 0	2 17 0
Mottled	2 16 6	2 16 6
White	2 16 6	2 16 6
MIDLANDS—		
(c) Staffs.—	(*Delivered to Station.*)	
All-mine (Cold Blast)	—	—
North Staffs. Forge	3 1 0	—
„ „ Foundry	3 6 0	—
(c) Northampton—		
Foundry No. 3	3 2 6	—
Forge	2 17 6	—
(c) Derbyshire—		
No. 3 Foundry	3 6 0	—
Forge	3 1 0	—
(3) Lincolnshire—		
No. 3 Foundry	—	—
No. 4 Forge	—	—
Basic	—	—
(4) N.W. COAST—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 1 6 (*a*) / 4 3 6 (*b*) / 4 8 6 (*c*)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
SCOTLAND—		
Crown Bars	10 5 0	9 15 0
Best	—	—
N.E. COAST—		
Iron Rivets	11 10 0	—
Common Bars	10 10 0	—
Best Bars	11 0 0	—
Double Best Bars	11 10 0	—
Treble Best Bars	12 0 0	—
LANCS.—		
Crown Bars	9 15 0	—
Second Quality Bars	8 5 0	—
Hoops	12 5 0	—
S. YORKS.—		
Crown Bars	10 0 0	—
Best Bars	10 15 0	—
Hoops	12 0 0	—
MIDLANDS—		
Crown Bars	9 10 0 to 10 7 6	—
Marked Bars (Staffs.)	12 0 0	—
Nut and Bolt Bars	8 12 6 to 9 0 0	—
Gas Tube Strip	10 17 6 to 11 0 0	—

STEEL. (*d*)

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) SCOTLAND—		
Boiler Plates (Marine)	10 10 0	10 10 0
„ „ (Land)	10 10 0	10 0 0
Ship Plates, ¾in. and up	8 15 0	7 15 0
Sections	8 7 6	7 7 6
Steel Sheets, ¼in.	7 10 0 to 7 15 0	8 0 0
Sheets (Gal. Cor. 24 B.G.)	11 7 6	11 0 0

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. COAST—		
Ship Plates	8 15 0	7 15 0
Angles	8 7 6	7 7 6
Boiler Plates (Marine)	10 10 0	—
„ „ (Land)	10 0 0	—
Joists	8 15 0	7 7 6
Heavy Rails	8 10 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5s.
Hard Billets	8 2 6	—
Soft Billets	6 17 6	—
N.W. COAST—		
BARROW—		
Heavy Rails	8 5 0	—
Light Rails	8 10 0 to 8 15 0	—
Billets	6 10 0 to 9 0 0	—
MANCHESTER—		
Bars (Round)	9 7 6	—
„ (Small Round)	6 15 0	—
Hoops (Baling)	10 0 0	9 15 0
„ (Soft Steel)	9 0 0	8 15 0
Plates	8 17 6 to 9 2 6	—
„ (Lancs. Boiler)	9 0 0	—
SHEFFIELD—		
Siemens Acid Billets	9 10 0 (basis)	—
Hard Basic	8 2 6 and 8 12 6	—
Intermediate Basic	7 2 6	—
Soft Basic	6 0 0 to 6 5 0	—
Hoops	9 10 0 to 9 15 0	—
Soft Wire Rods	7 15 0	—
MIDLANDS—		
Small Rolled Bars	6 15 0 to 7 5 0	—
Billets and Sheet Bars	5 2 6 to 5 15 0	—
Galv. Sheets, f.o.b. L'pool	10 5 0 to 10 10 0	—
(2) Staffordshire Hoops	9 10 0	—
(*d*) Angles	8 7 6	—
(*d*) Joists	8 15 0	—
(*d*) Tees	9 7 6	—
(*d*) Bridge and Tank Plates	8 17 6	—
Boiler Plates	9 0 0	—

NON-FERROUS METALS.

SWANSEA—	
Tin-plates, I.C., 20 by 14 f.o.b.	14/– to 14/3
Block Tin (cash)	100 12 6
„ (three months)	102 0 0
Copper (cash)	35 1 3
„ (three months)	35 15 0
Spanish Lead (cash)	10 13 9
„ „ (three months)	11 1 3
Spelter (cash)	9 16 3
„ (three months)	10 6 3
MANCHESTER—	
Copper, Best Selected Ingots	39 10 0
„ Electrolytic	41 0 0
„ Strong Sheets	70 0 0
„ Tubes (Basis Price), lb.	0 0 10¼
Brass Tubes (Basis Price), lb.	0 0 9½
„ Condenser, lb.	0 0 11½
Lead, English	12 5 0
„ Foreign	10 17 6
Spelter	10 7 6
Aluminium (per ton—raw ingot)	£85

FERRO ALLOYS.

	Per Ton.	Per Unit.
Tungsten Metal Powder	1/11¼ per lb.	
Ferro Tungsten	1/8½ per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£21 0 0	7/–
„ „ 6 p.c. to 8 p.c	£20 0 0	7/–
„ „ 8 p.c. to 10 p.c.	£20 0 0	7/–
„ „ Specially Refined		
„ „ Max. 2 p.c. carbon	£31 0 0	10/–
„ „ „ 1 p.c. carbon	£34 0 0	12/–
„ „ „ 0·70 p.c. carbon	£36 0 0	14/–
„ „ „ carbon free	10d. per lb.	
Metallic Chromium	2/7 per lb.	
Ferro Manganese (per ton)	£11 0 0 for home	
„ „ „	£11 10 0 for export	
„ Silicon, 45 p.c. to 50 p.c.	£10 10 0 scale 5/– per unit	
„ „ 75 p.c.	£15 0 0 scale 7/– per unit	
„ Vanadium	12/9 per lb.	
„ Molybdenum	4/2 per lb.	
„ Titanium (carbon free)	9d. per lb.	
Nickel (per ton)	£170	
Ferro Cobalt	9/– per lb.	

FUELS.

SCOTLAND.

	Export.
LANARKSHIRE—	
(f.o.b. Glasgow)—Steam	14/–
„ „ Ell	14/– to 14/6
„ „ Splint	14/6 to 16/3
„ „ Trebles	11/– to 11/6
„ „ Doubles	10/3 to 10/6
„ „ Singles	9/–
AYRSHIRE—	
(f.o.b. Ports)—Steam	13/–
„ „ Jewel	17/–
„ „ Trebles	11/6
FIFESHIRE—	
(f.o.b. Methil or Burntisland)—Steam	10/3 to 11/9
Screened Navigation	16/6 to 17/6
Trebles	11/6 to 13/–
Doubles	10/9
Singles	9/–
LOTHIANS—	
(f.o.b. Leith)—Best Steam	11/– to 11/3
Secondary Steam	10/6
Trebles	12/–
Doubles	11/–
Singles	8/9

ENGLAND.

(8) N.W. COAST—	
Steams	20/–
Household	30/– to 51/–
Coke	20/– to 20/6
NORTHUMBERLAND—	
Best Steams	13/6
Second Steams	12/–
Steam Smalls	7/6 to 8/–
Unscreened	12/6 to 13/–
Household	27/– to 39/–
DURHAM—	
Best Gas	14/6
Second	13/3 to 13/6
Household	25/– to 37/–
Foundry Coke	24/–
SHEFFIELD—	Inland.
Best Hand-picked Branch	25/6 to 27/–
Derbyshire Best Bright House	20/– to 22/–
Best House Coal	20/– to 21/–
Screened House Coal	18/– to 19/–
„ „ Nuts	15/– to 16/–
Yorkshire Hards	15/– to 16/6
Derbyshire Hards	15/– to 16/6
Rough Slacks	9/– to 10/–
Nutty Slacks	7/– to 8/–
Smalls	4/6 to 6/6
Blast-furnace Coke (Inland)	12/3 on rail at ovens
Furnace and Foundry Coke (Export), f.o.b.	14/– to 15/–

(9) SOUTH WALES.

CARDIFF—	
Steam Coals :	
Best Smokeless Large	20/– to 20/3
Second Smokeless Large	18/9 to 19/9
Best Dry Large	18/6 to 19/6
Ordinary Dry Large	17/9 to 18/–
Best Black Vein Large	18/3 to 18/9
Western Valley Large	18/– to 18/6
Best Eastern Valley Large	17/9 to 18/–
Ordinary Eastern Valley Large	17/9 to 18/–
Best Steam Smalls	13/6 to 14/–
Ordinary Smalls	11/6 to 13/3
Washed Nuts	18/– to 21/–
No. 3 Rhondda Large	19/9 to 20/3
„ „ Smalls	15/6 to 16/–
No. 2 „ Large	17/– to 17/3
„ „ Through	15/6 to 16/–
„ „ Smalls	14/– to 14/3
Foundry Coke (Export)	22/– to 36/6
Furnace Coke (Export)	16/6 to 17/6
Patent Fuel	20/6 to 21/–
Pitwood (ex ship)	22/9 to 23/3
SWANSEA—	
Anthracite Coals :	
Best Big Vein Large	35/– to 37/6
Seconds	27/– to 31/6
Red Vein	22/6 to 27/6
Machine-made Cobbles	41/6 to 45/–
Nuts	43/– to 46/–
Beans	24/9 to 28/3
Peas	20/– to 21/6
Breaker Duff	8/6 to 9/–
Rubbly Culm	8/6 to 9/6
Steam Coals :	
Large	20/6 to 21/6
Seconds	18/– to 20/–
Smalls	11/6 to 13/–
Cargo Through	16/– to 17/6

(1) Delivered. (2) Net Makers' Works. (3) f.o.b. Makers' Works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire. (6) Home Prices—All delivered Glasgow Station. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. (*a*) Delivered Glasgow. (*b*) Delivered Sheffield. (*c*) Delivered Birmingham. (*d*) Rebate : Joists (minimum), 22/6 ; Ordinary Ship, Bridge, and Tank Plates and Sections, 15/– if home consumers confine purchases from associated British Steel Makers. (*e*) Delivered Black Country Stations.

French Engineering Notes.

(From our own Correspondent in Paris.)

Industrial Organisation.

WHILE there are plans to organise international trade on lines that are largely political and financial, something has already been done in the way of conciliating interests and distributing business by the formation of cartels amongst groups of producers. The situation called for co-operation in national industries, and this has been followed by international agreements whereby the participation in foreign trade is determined by quotas or by a delimitation of territory. As the national groups increase in power by amalgamation, so the international arrangements become more important, relating as they do to semi-manufactured steel, rails, tubes, railway wagons, the chemical industries, and so forth. Experience has shown that such arrangements are only possible when the national organisations are complete and when the cartel plans are not liable to be upset by the competition of outside producers. As it is difficult to secure these conditions, opinion in this country is now more in favour of a delimitation of markets, which would obviously simplify matters if the markets themselves would accept dependence upon particular producing countries. The German method is an attempt to secure a monopoly of markets in Central Europe, and it remains to be seen how this plan will fall in with the general scheme for a reorganisation of international trade. These industrial agreements aim at adjusting production to consumption, while the main scheme being prepared at Geneva is intended primarily to bring prosperity to agricultural countries and increase their purchasing power.

Oil Supplies.

The Office National de Combustibles Liquides was formed at a time when the French were alarmed at finding themselves at the mercy of foreign oil supplies which might become insufficient in view of the enormously increasing world consumption. While the fears of a shortage are no longer justified, the French have nevertheless deemed it prudent to carry out a definite policy of oil development that may render them independent of the oil companies. What that policy is, and how far its objects have been attained, were explained at a conference held at the International Colonial Exhibition by the Office National des Combustibles Liquides. The first object was to ascertain whether oil could be found in France and in French territories. The Pechelbron Company in Alsace is the only producer of oil on a small scale, and the borings carried out elsewhere have given such poor results that all hope of finding oil in France outside Pechelbron has been abandoned. A considerable amount of prospecting work has shown that there are traces of oil in most of the colonies. The oil is extensively distributed, but there is nothing to indicate that the traces can be taken as evidence of the existence of oil-bearing strata, except in Morocco, where a small quantity of oil is being produced. The results of these expensive efforts are so far discouraging that any production of oil in the colonies on a commercial scale is now regarded as doubtful. Nevertheless, it is hoped that with a better knowledge of geological formations and with a great expenditure of time and money it may be possible in years to come to obtain oil from the colonies. Meanwhile the French accept their dependence upon foreign supplies, and they have formulated a policy to enable them to exploit the situation to the best advantage. In the first place, statistics show that none of the large oil-producing countries has a surplus for export, except the United States, Russia and Iraq. Even in the United States it is observed that the oil companies import crude oil to an extent that fairly counterbalances the exports of petrol, so that the United States may be regarded as absorbing its own production. Moreover, the companies are distributors as well as producers, and their control of the market is not acceptable to the French. The Russian supplies are increasing, and if the five years' plan should be carried through as arranged the output will be doubled. The French feel that they must free themselves from the control of foreign companies, which may place them in an extremely difficult position in case of emergency. There are oilfields in Mexico, Venezuela, Columbia and other South American States which do not admit the participation of foreign companies backed up by their respective Governments, and French private firms are therefore being formed to take a direct interest in South American oil wells. When this French participation in a number of comparatively small oilfields in South America and elsewhere is completed some way must be found of "canalising" the oil to France. The future is rendered more encouraging by the share in the Mosul oilfields which the French secured at the San Remo conference. Monsieur Pineau, Director of the Office National des Combustible Liquides, declares that this oilfield will eventually become the most important in the world and will dominate the oil situation. As France has a voice in everything relating to the Mosul oil supplies, the French consider that in time they will have a controlling interest, even as they have been able to ensure the construction of a pipe line through Syria in addition to the one through Palestine. On the whole, the conference showed that the French are satisfied with what has been accomplished in the way of obtaining uncontrolled supplies of oil in the future.

Cast Iron Pipes.

Some trouble has arisen over an order for cast iron pipes required by the District of Columbia, United States, for which the lowest tender of 66·80 dollars per ton f.o.b. Washington was submitted by Pont-à-Mousson. The American pipe manufacturers have made a strong protest against the order going out of the country during the present time of trade depression, particularly in view of the fact that some of the American tenders are claimed to have been only a few cents a ton above that of the French. It is reported that if the acceptance of the lowest tender is withdrawn the French firm will refer the matter to the State. The American authorities have replied to the American protest to the effect that the samples of French cast iron pipes will be carefully inspected and that if they fall short of the specification further tenders will be invited.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

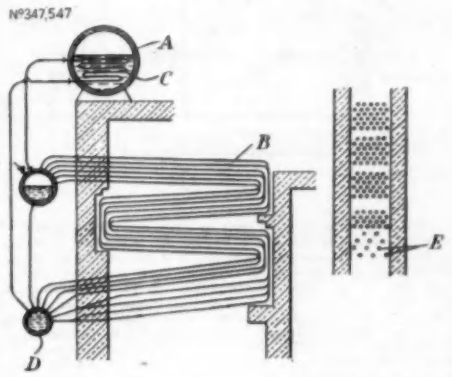
Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

347,547. July 8th, 1930.—WATER-TUBE BOILERS, *The Superheater Company, Ltd., Bush House, Aldwych, London, W.C. 2.*

This boiler is of the indirectly heated type; that is to say, the water in the boiler A is evaporated by the heat of the steam generated in the hairpin tubes B exposed to the fire, which is condensed in the coils C in the boiler A and returned to the water

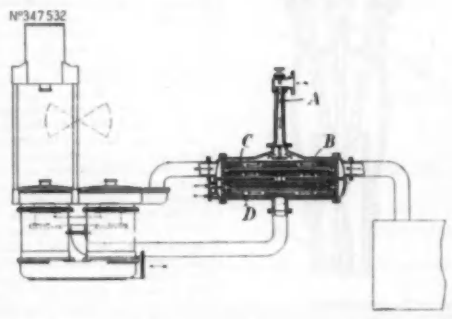


drum D. It is suggested that in such a boiler, especially if it is fired with powdered coal, there is a tendency for the tubes immediately above the fire to be slagged together, to the detriment of the draught through the boiler. The inventors consequently space the first few rows of tubes well apart, as is shown at E, and claim that in this way the trouble is overcome.—*April 30th*, 1931.

CONDENSERS AND FEED-WATER HEATERS.

347,532. June 18th, 1930.—CONDENSING PLANTS, G. and J. Weir, Ltd., Cathcart, Glasgow, and J. Sim.

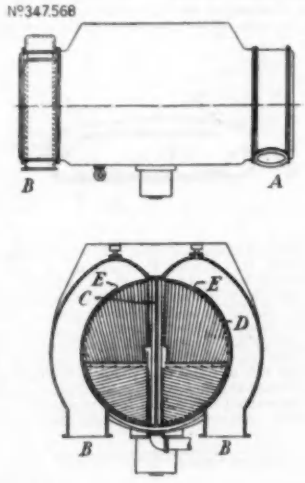
This invention aims at permitting a steam turbine vessel equipped with the "paragon" system of condensation to develop full power during manœuvring. Such a condition has not been possible in the past, as the condensate from the main condenser



is used to condense the discharge from the vacuum augmenter jet A, and if the main engines are running intermittently the amount of the condensate is not sufficient for the purpose. The inventors provide the inter-condenser B with two separate sets of cooling tubes. Through one, C, the main condensate passes, while the other, D, is supplied with sea water by the main condensing pump or some other means.—*April 30th*, 1931.

347,568. October 6th, 1930.—CONDENSERS, *Associated Electrical Industries, Ltd., Bush House, Aldwych, London, W.C. 2.*

The object of this invention is to ensure the flooding of the

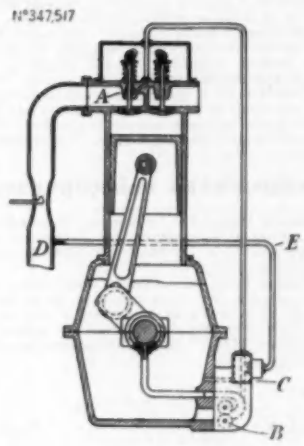


whole of the circulating water tubes of a condenser, regardless of the rate of flow of water and yet provide a bottom outlet, so as to economise in the piping arrangement. In the drawings the inlet is shown at A and the two outlets at B B. The water box is divided by the diaphragm C, so that either half can be cleaned separately. Within the water box there is another—circular—diaphragm D, over the lips E E of which the water must spill before it can get to the outlets. This diaphragm does not obstruct access to the tubes.—*April 30th*, 1931.

INTERNAL COMBUSTION ENGINES.

347,517. May 30th, 1930.—VALVES OF INTERNAL COMBUSTION ENGINES, H. Junkers, 21, Kaiserplatz, Dessau, Anhalt, Germany.

The inventor explains that if the stem of the inlet valve of an oil engine becomes slack in its bushing there is a liability for fuel oil to be forced through the clearance and to contaminate the oil used to lubricate the valve gear. Consequently he provides the bushing with a recess A, to which lubricating oil is supplied

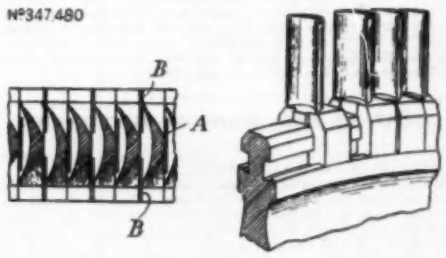


at a pressure exceeding that of the cylinder compression by the main lubricating pump B, with the result that any leakage must be that of lubricating oil, not of fuel oil. In order to minimise the wastage of oil the pressure of that supplied to the recess A is controlled by the regulator C, which is in communication with the inlet D by the pipe E, so that the oil pressure in the recess A is appropriate to the load on the engine.—*April 30th*, 1931.

TURBINE MACHINERY.

347,480. April 25th, 1930.—STEAM TURBINE BLADING, *The British Thomson-Houston Company, Ltd., Crown House, Aldwych, London, W.C. 2.*

In this specification it is pointed out that the relative circumferential expansion of a ring of blading and the disc to which it is attached, on change of temperature of a steam turbine, may produce serious stresses in the periphery of the disc.

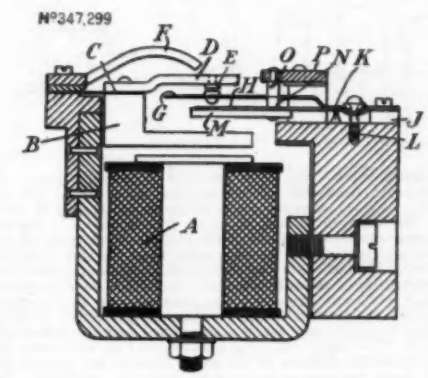


As a consequence, the inventor spaces the blades slightly apart round the circumference, so that there is room for expansion, and maintains the spacing by means of flexible webs A and B B. These webs give way when expansion takes place, but there is no hint in the specification as to whether, or not, they will recover their normal form on the reduction of the difference in temperature of the blading and the disc.—*April 30th*, 1931.

SWITCHGEAR.

347,299. January 30th, 1930.—COMBINED ELECTRIC CUT-OUTS AND VOLTAGE OR CURRENT REGULATORS, Joseph Lucas, Ltd., King-street, Birmingham, and Charles Edwin Robinson, of 403, Princes-gardens, West Acton, London, W. 3.

This invention relates to electric current controlling or regulating devices, particularly intended for use on motor vehicles for controlling or regulating the current generated for lighting,



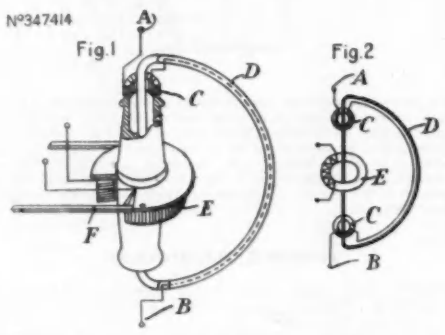
ignition and other purposes. Adjacent to one end of the magnet A an armature B is pivoted and is controlled by a blade spring C, and at the outer side of the armature is secured a projection D carrying a contact piece E. F is a stop for limiting the movement of the armature in one direction. Between the projection D and armature B are the free ends of a pair of spring blades carrying a pair of contacts. These blades are composed of

movable spring strips G, H, the latter being preferably stiffer than the former. The strip G carries a contact which can co-operate with the contact E on the part D, and also an abutment which serves to transmit movement to the part H. Both parts G, H are secured at one end by a screw to a fixed block J. In addition, the part H is supported on a knife edge K, and a screw L and convex washer are provided for regulating the stiffness of the part H. To prevent deflection of the free end of the part H it is stiffened at its underside by a strip M. The part H carries a contact N and this co-operates with a fixed contact O on the stationary bridge piece P, the part G being gapped to clear these contacts. When the magnet A is sufficiently excited, the first effect of the movement of the armature B is to bring together the contact E on the armature projection and that on the adjacent blade part G. This causes the circuit between the dynamo and the battery to be closed, and the part G is now pressed against the stiffer part H. If the voltage generated by the dynamo exceeds a predetermined limit the armature receives a further movement, causing the other pair of contacts O, N to be separated, thereby bringing a resistance into the field winding of the dynamo. Alternatively, the extra movement of the armature may be made dependent on the amount of current generated by the dynamo. When the excitation of the magnet weakens, the reverse effect occurs, the pair of contacts O, N being allowed to come together, and, finally, the other pair to be separated. In this way it is possible to provide for the required automatic control and regulation in a very simple and convenient manner.—*April 30th*, 1931.

TRANSFORMERS AND CONVERTERS.

347,414. March 19th, 1930.—CURRENT TRANSFORMERS, Compagnie pour la Fabrication des Compteurs et Materiel D'Usines a Gaz, of 12, Place des Etats Unis, Montrouge (Seine), France.

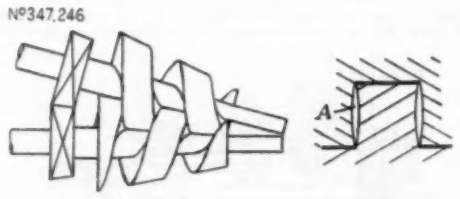
This invention refers to a current transformer intended to enable currents to be measured with great precision and which can be constructed for measuring a very weak current, whilst the insulation may be obtained by means of a single bushing insulator. The working of the apparatus will be understood from Fig. 1. The apparatus is inserted between A and B in the line, which carries a current which may be very weak. The current in this line, passing along the turns of C, is transformed into a current of high intensity, in the single conductor D. This current is transformed afterwards by means of the transformer F into a current the intensity of which is suited to the measuring apparatus to be used. In order to increase the accuracy, several auxiliary transformers may be used, as shown in Fig. 2.—*April 30th*, 1931.



PUMPING AND BLOWING MACHINERY.

347,246. January 20th, 1930.—SCREW PUMPS, J. H. H. Goodall, The Old House, Tickhill, Yorks.

We give the essence of this specification just as it is printed:—Two or more screws, each comprising a helical thread on a suitable axle, are mounted in bearings alongside one another, with the thread of one screw engaging the helical channel of the other. The screws are contained in a casing shaped to fit the exterior surfaces of the screw threads and provided with suitable end plates or covers. The axles of the screws are geared together in such manner that the screws may be rotated without fouling their engaging threads. Means are provided for admitting fluid at one end of the casing and for discharging or conveying it from the other end. It will be appreciated that the construction is such that a series of pockets is provided around each screw axle, each pocket extending from the point where the threads of the screws engage one another, around the screw axle to the next point of engagement of the threads and being completed by the casing, which, in the case of two screws, preferably extends in a figure-of-eight section to meet the engaging parts of the screw threads in a knife edge on each side. When more than two screws are used, the casing shape is modified accordingly. Thus, rotation of the screw causes fluid contained in the pocket of each screw at one end to be carried to the other end, thereby effecting a pumping or blowing action.

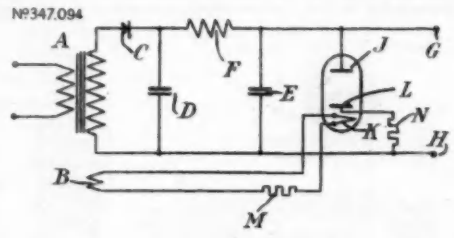


The screw threads are of a modified rectangular form, the modification consisting in making the sides of the threads concave to the extent necessary to allow one thread to mesh with the other in known manner. The screws are tapered and thus compress the fluid in the threads. The hollowing of the sides of the threads leaves a space A on the accompanying drawing. The leakage of fluid through this space will be decreased by wire-drawing at each successive thread, as in a labyrinth packing, sufficient threads being used to suit the pressure. In a convenient construction, two tapered screws are provided of opposite pitch, one being right-handed and the other left-handed. The body comprises a casing and an end-plate, the casing to fit the exterior of the screw threads, bearings for the screw axles being provided in the end-plate portions. The screw axles project through the end-plates, suitable stuffing-boxes being provided if desired and the axles are geared together to rotate in opposite senses. Suitable provision is made for lubrication and the circulation of cooling fluid, if desired. By making the screws tapered or conical, compression of the fluid will be effected since the size of the pockets will decrease from the wider end towards the narrower ends of the tapers. In all its forms, the mechanism may also be used as a motor by supplying fluid under pressure at the end of the screw threads and exhausting at a lower pressure at the other.—*April 30th*, 1931.

MISCELLANEOUS.

347,094. November 12th, 1929.—CIRCUIT ARRANGEMENTS FOR MAINTAINING CONSTANT VOLTAGE, Laszlo Körös, of 6, Hohenzollernkorso, Berlin-Tempelhof, Germany.

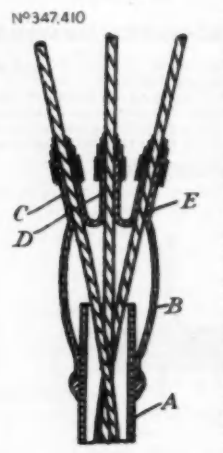
According to this invention, an arrangement is provided for maintaining constant voltage in an electrical circuit. The source of current having a relatively high internal resistance comprises the transformer A, the primary winding of which is connected to an A.C. supply, while two voltages are tapped off from the secondary side, one of which is rectified for the consumer and the other—from the winding B—serves for heating a glow-cathode discharge tube J. To the secondary winding the rectifier C and a smoothing circuit consisting of the capacities D, E and the inductance F, are connected. In order to maintain constant voltage at the terminals G and H independently of the changes of load, the glow-cathode discharge tube J, filled with



a suitable gaseous medium such as neon, is inserted between the terminals and the cathode L heated by a heating winding K connected to the secondary winding B of the transformer through the regulating resistance M. One or more auxiliary electrodes may also be provided in the tube. With this arrangement the tube exerts a powerful stabilising action on the voltage, such as is characteristic of a condenser of very large capacity. For this reason, the discharge tube is also adapted for doing the work of the condenser E, and the latter may, therefore, be dispensed with without any harmful results. As the glow-cathode discharge tube possesses an inclining characteristic, an ohmic resistance N, which has a positive characteristic, may also be connected in series with the tube.—*April 13th*, 1931.

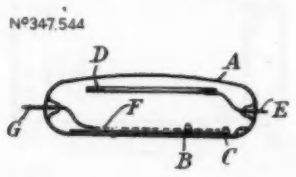
347,410. March 15th, 1930.—ELECTRICAL TERMINAL BOXES, Siemens-Schuckertwerke Aktiengesellschaft, of Berlin-Siemensstadt, Germany.

This specification describes a combined electrical terminal box and device for preventing the escape of cable compound from multi-core cables and having a sealing cap arranged over the outer lead sheath at the cable end. A is the lead sheath of a three-core cable, with metallised individual cores. A sealing cap B is placed over the lead sheath common to the three cores. The cap has tubular extensions, C, D and E for the passage of the individual cores. The cap B is of small dimensions and only requires a small amount of compound to fill it, thus reducing the risk of fumes in the case of fires to a minimum. A pressure-proof and oil-proof joint is formed between the sealing cap B and the lead sheath A by soldering. In order to prevent the escape of compound between the tubular extensions and the insulation of the three cores, the tubular extensions are made pressure-tight and oil-tight by cording with fibrous material. In cables with metallised individual cores, the tubular extensions must be connected electrically with the metallised coverings of the individual cores. In damp and dusty places it is preferable, in order to avoid glow discharge and flash-over, to protect the cores against moisture and dust by a protecting sheath, such as a terminal box not filled with compound.—*April 30th*, 1931.



347,544. July 5th, 1930.—PHOTO-ELECTRIC CELLS, N. V. Philips' Gloeilampenfabrieken, Emmasingel 13A, Eindhoven, North-Brabant, the Netherlands.

The chief object of this invention is to produce a photo-electric cell in which the intensity of the current which passes through the cell is increased. The photo-electric cell illustrated comprises a glass envelope A, one wall of which is pratically covered by a photo-active electrode B. The photo-active substance embodied in this electrode may be an alkali metal, such as potassium or caesium. The photo-active electrode is connected to a leading-in wire C sealed into the wall of the cell. The cell also contains an annular anode D through the middle of



which light can pass to the cathode. The anode is provided with a leading-in wire E. A grid F consisting of thin wires and connected to the leading-in wire G, is arranged at a small distance, say, 1 mm., from the cathode B. The cell is filled with a suitable gas, as, for example, neon or argon. The pressure of the gaseous filling is about 1 mm. of mercury. When the cell is in use, the grid F is raised to a suitable potential, which is not greater than 10 volts. The distance between the grid F and the cathode B is so small that the field between the cathode and the grid causes the electrons emitted by the cathode B to attain such a speed that they do not tend to return to the cathode, or only to a very small extent.—*April 30th*, 1931.

THE INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—The fourth annual golf competition in aid of the Institution Benevolent Fund for the trophy presented by Messrs. W. L. Winning and Andrew Hutcheson, which was arranged for June 11th, has been cancelled.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

INSTITUTION OF GAS ENGINEERS.—At the Institution of Civil Engineers, Great George-street, Westminster, S.W. 1. First International Gas Congress and sixty-eighth annual general meeting. For programme see page 585.

INTERNATIONAL FEDERATION FOR HOUSING AND TOWN PLANNING.—Berlin. Thirteenth International Housing and Town Planning Congress.

PHYSICAL SOCIETY.—Imperial College of Science, Imperial Institute-road, South Kensington, S.W. 7. Meeting at 5 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, Piccadilly, W. 1. Discourse, "Habit: The Driving Force in Evolution," by Dr. E. W. MacBride. 9 p.m.

TO-DAY TO SUNDAY, JUNE 14TH.

INSTITUTE OF TRANSPORT.—Italian Tour and Congress. For provisional programme see page 359.

WEDNESDAY, JUNE 10TH.

INSTITUTE OF BRITISH FOUNDRYMEN.—Grand Hotel, Birmingham. Twenty-eighth annual general meeting and conference. 9.15 a.m.

INSTITUTION OF STRUCTURAL ENGINEERS.—10, Upper Belgrave-street, London, S.W. 1. Lecture and demonstration, "The Art of Making and Using Concrete—Lecture II.: The Raw Materials of Concrete and their Field Testing," by Mr. H. A. Holt. 8 p.m.

SOCIETY OF MODEL AND EXPERIMENTAL ENGINEERS.—Caxton Hall, Westminster, S.W. 1. Presidential address, by Sir Felix J. C. Pole. 7 p.m.

WEDNESDAY TO SATURDAY, JUNE 10TH TO 13TH.

NEWCOMEN SOCIETY.—Summer meeting at Sheffield. For programme see page 637.

THURSDAY, JUNE 11TH.

OPTICAL SOCIETY.—At the Imperial College of Science and Technology, Imperial Institute-road, South Kensington, S.W. 7. The Thomas Young Oration, "Young's Theory of Colour Vision," by Sir John H. Parsons, F.R.S. 8 p.m.

WEDNESDAY, JUNE 17TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS (LONDON): BIRMINGHAM CENTRE.—Visit to the Austin Motor Company, Ltd., Coventry Works. 2 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Afternoon visit to York.

WEDNESDAY TO SATURDAY, JUNE 17TH TO 20TH.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—Birmingham. Fifty-eighth annual general meeting and conference. For programme see page 524.

WEDNESDAY, JUNE 24TH.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Annual excursion. Visit to the National Physical Laboratory, Teddington.

MONDAY TO SATURDAY, JUNE 29TH TO JULY 4TH.

INSTITUTION OF NAVAL ARCHITECTS.—Paris summer meeting. For programme see page 514.

THURSDAY, JULY 9TH.

BRITISH ELECTRO-FARMING CONFERENCE.—In the Members' Large Tent, Royal Agricultural Show, Warwick. Sixth Conference. "Electricity on the Farm, including Dairy and Poultry Farming," by Mr. M. M. Harvey. 3 p.m.

MONDAY TO SATURDAY, JULY 13TH TO 18TH.

SOCIETY OF CHEMICAL INDUSTRY.—Jubilee Celebrations. For provisional programme see page 471.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

DUNFORD AND ELLIOTT (SHEFFIELD), Ltd., of 54, Victoria-street, S.W. 1, has purchased the goodwill and patent rights of Rotary Louvre Furnaces (System Pehrson), Ltd.

THE PULSOMETER ENGINEERING COMPANY, Ltd., has removed its London office from 11, Tothill-street, S.W. 1, to 39, Victoria-street, S.W. 1. Telegraphic address, Pulsometer, Parl, London; telephone number, Victoria 4565.

JOSEPH STUBBS, Ltd., of Ancoats, Manchester, has taken over the patent rights for the Diatherm piston. The piston, which is the invention of Monsieur Raymond de Fleury, will be manufactured at the company's works.

CONTRACTS.

THE MOSS GEAR COMPANY, Ltd., of Crown Works, Tyburn, Birmingham, has received an order for 377 worm reducing gears and also 42 double helical reducing gears.

DUNFORD AND ELLIOTT (SHEFFIELD), Ltd., of 54, Victoria-street, S.W. 1, has received from the Consolidated Mining and Smelting Company (of Canada), Ltd., orders for two rotary louvre furnaces to dry 150 tons of sulphate of ammonia per day.

THE CLARKSON THIMBLE TUBE BOILER COMPANY, Ltd., of 613, Australia House, London, W.C. 2, has received an order for five silencer boilers for the Bank of England, each to work in conjunction with a 750 H.P. oil engine of the Harland-B. and W. type. These silencer boilers will be used for the production of hot water for heating the buildings.

THE WESTINGHOUSE BRAKE AND SAXBY SIGNAL COMPANY, Ltd., of 82, York-road, King's Cross, N. 1, has received orders from the Associated Equipment Company, Ltd., of Southall, for fifty-eight vacuum servo brake sets for "Regent" omnibuses for the Birmingham Corporation; and from Ransomes, Sims and Jefferies, Ltd., of Ipswich, for ten pressure brake sets for trolley omnibuses for the Nottingham Corporation.